POWER

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Smoke Abatement

IT is in keeping with human nature and with the way in which things engineered and motivated by man progress by spurts and surges that there should be periods of intensive activity in connection with the suppression of the smoke nuisance, followed by intervals of laxity, tolerance and retrogression.

However earnest and persistent the director of the effort and his assistants may be, it is difficult to maintain in the public mind a compelling and supporting interest that will keep up the initial élan or even hold the progress that has been made.

When the most egregious offenders have been suppressed and the most offensive manifestations of the nuisance brought under control, the citizen is less ready with expressions of appreciation and approval and with insistence upon continued activity.

He does not realize the extent to which the vitalizing effect of the sunlight is shut off by even a thin veil of smoke. He has no idea of the enormous collective cost of the disfigurement of buildings, the soiling of furnishings and clothing and of goods in stock. He cannot visualize a Spotless Town with its superior healthfulness and attractiveness.

The arguments and representations of those who do appreciate the seriousness of the smoke nuisance, the utter needlessness of it, its depressing effect upon values and the saving in actual money as well as the aesthetic effect of its suppression become a twice-told tale and provoke little enthusiasm and assistance from public or officials, especially if the need of funds is involved.

The smoking chimney and an atmosphere of grime have lost their significance as symbols of prosperous activity. We can be just as prosperously active and be better off without them. The saying that "Dirty jobs make clean money" has been used to excuse a lot of unnecessary filth.

Just as in picking a homesite the customer looks for a clean, sightly location that is not likely to be depreciated by unpleasant influences, so in choosing a home town he is not likely to be attracted by one that is polluted by a cloud of smoke.

Let the good work be pursued, not with a club, except for the recalcitrant, but with intelligent guidance by those who know how of those who would like to be decent if they knew how to do it.

F. R. Low

EDITORIALS

Policies Platform For American Business

NO MATTER what their walk in life, people generally agree that the depression of 1929 and 1930 has been filled with lessons.

Moreover, the feeling of cocksureness, of conviction that old economic rules had served their last and had no bearing in the new order, has given way to a contrite willingness to be shown and to listen to experts whose warnings previously went unheeded.

How the country "got that way" is not now of such pressing importance as how to rebuild the structure so it may not occur again. This is a large contract and it is engaging constructive minds everywhere.

Its solution first requires a clear exposition and setting down of the principles or policies from which Business may take direction.

The Platform for American Business, which appears as a supplement to this number of *Power,* contrives to do just this. It has been prepared by the McGraw-Hill Publishing Company after long study, and is offered, not as a direct solution or formula for perpetual prosperity, but as a means for focusing thought upon the factors involved in universal teamwork and the individual's relationship thereto. Its earnest study and application must precede the result so much desired.

It is not expected that each person or company will find the solvent for every specific problem. Business is too complex and ramified for that. Intelligent introspection, coupled with the ability to interpret and apply the principles laid down, to his individual case should, nevertheless, result in the unity of direction so greatly needed now and in the future.

There will be differences of opinion as to some planks. What is sauce for the goose is not always palatable to the gander. In such cases it must not be forgotten that despite individual taste all are entitled to a full dinner pail.

Every person following the precepts of the Platform will automatically enlist in the army of co-operation necessary to economic victory.

The Platform warrants serious and protracted thought, wide distribution, discussion and application. Extra copies are available in limited number.

Supercharging Is One Answer

SOMEONE has pointed out that where the cost of power with oil engines is but slightly less than the cost when power is obtained from other sources, the oil engine seldom is installed. Without going into the psychological basis for the reaction by the consumer, it is obvious that the oil engine manufacturer must recognize this situation and devise ways and means of increasing the differential in power costs.

Little can be done to reduce the fuel consumption, for present thermal efficiency can be bettered but slightly. Labor costs are, as a politician once said of the tariff, a local issue, and must rise and fall with the general wage scale. Lubricating oil, maintenance and the other minor operating expense terms are more or less incapable of any but slight reductions. Obviously, then, the only practical method is to reduce the fixed charges.

These can be reduced only by lowering the initial investment per horsepower, and to bring this about four avenues of approach are available.

Cheaper material would lead to a lower manufacturing cost, but would result, in all probability, in increased maintenance, thereby offsetting the reduction in fixed charges.

An engine may be rated higher per unit of cylinder volume. This entails the combustion of more oil with the air charge, which brings up a serious problem of spray valve design, if a correct mixture is to be obtained, as well as heightened heat stresses. With better material this heat stress might not be dangerous, but better material costs money.

A third solution is the speeding up of the engine, which is being done at the present time. Designers have found, however, that a high-speed diesel cannot be made by merely speeding up a slow-speed unit; an entirely different design is necessary. So far the higher speeds have been obtained only with the employment of expensive alloys, so raising the engine cost on the pound basis that the cost on the horsepower basis has remained unchanged.

The final solution is supercharging. At the present time a number of motorships are powered with super-

charged engines, but few stationary engines are arranged to be pressure-charged with air (and these applications have been mainly to compensate for altitude effects).

Supercharging at low loads should present no difficulties, and thermally should give a better cylinder efficiency, since the air-to-oil ratio would be greater than in the case of a normally charged engine. Of course, if the supercharger were motor-driven there would be a loss in drive efficiency, but even at low loads the exhaust gases should be able to drive the blower. For that matter, after the engine has become warm the supercharger could be disconnected, as the temperature would be still high enough to insure ignition in spite of the lower compression pressure.

By increasing the maximum output of 50 per cent through supercharging, as its advocates claim, engine costs would be reduced sharply. As the remainder of the installation would remain unchanged in cost, the total net reduction in investment per horsepower would be substantial enough to widen the field of diesel application.

Radium for Engineers

ATOMIC ENERGY has entered the power plant, but as a detective rather than a power source. Scientists see no immediate possibility of releasing the great stores of locked-up atomic energy to light streets, move trains and drive factories. Yet that same energy has already been put to work for the benefit of power producers, and its application should spread rapidly.

An article in *Power* last week told of applications of "gamma" rays in the power filed. This radiation, one of several given off by radium and other radioactive substances, resembles the X-ray in that it is invisible light of very short wave length. Gamma rays, however, have greater penetrating power than X-rays from any machines yet built or contemplated. This radiation, therefore, extends the field of industrial radiography. Passing through four inches, six inches and even eight inches of solid steel, Gamma rays will register flaws on photographic films. And, it is stated on good authority, they will do this within commercial limitations of exposure time and investment in radioactive substances.

As pointed out by Messrs. Mehl and Barrett in the *Power* article, it is not necessary to use radium itself. The shadow pictures may be taken with a small capsule of radium emanation, a radioactive gas constantly given off by the parent radium. The emanation is pumped off as desired into special containers which may safely be transported in lead boxes.

The power engineer can rest content with the knowledge that men, methods and materials are available for testing the soundness of steel castings and other heavy metal parts which will be increasingly used in the era of high pressures.

Three Strikes And Out?

IN BASEBALL three strikes is "out," but in politics you cannot tell. Legislative batters at Albany, N. Y., are warming up for a third swing at the ball, hoping the pitcher will have one of those off moments.

Killed in 1929, and again in 1930, there pops up for the third time, and in identical form, a bill designed to turn power plant steamfitting into a first-class "racket."

It is getting monotonous, but brings home the truth of the old saw, "Perpetual vigilance is the price of freedom." The following editorial was published in *Power* when the bill came up last year. This year the same gander seems to call for the same sauce. The paragraphs here quoted apply word for word to the situation now threatening plant owners and operators in New York State:

> DISGUISED as a measure in the interest of public health and safety, a new, legalized "racket" threatens the owners and builders of power plants in the State of New York. A bill now before the Legislature in Albany will, if carried, tie the hands of power men with impractical restrictions and encumber their plants with red tape and politicians.
>
> Briefly, the plan is this: A division of steam power and heating plants will be set up in the Department of Labor, with practical pipefitters as inspectors. A code for the construction and alteration of steam power and heating plants is to be prepared. All plans for new plants and alterations must be submitted for approval (with $10). Existing plants are subject to review. All master steamfitters must register and get cards. Those found working on a plant without cards will be subject to heavy fines.
>
> Complete enforcement of this bill would be impossible. A strictly law-abiding plant owner could not connect a one-inch outlet to an existing low-pressure steam main without first filing plans (with $10) and patiently waiting for official approval. Plants already built must conform to a future code. If the plants do not fit the code, they may have to be rebuilt.
>
> As the bill reads, it applies to every phase of plant construction. Steamfitter inspectors may even pass on furnace-wall construction, turbine foundations, switchboards and stacks. Nothing, apparently, is exempt.
>
> Granting an honest difference of opinion as to the desirability of supervision over the installation of power equipment, besides boilers, the problem should be approached through a collaboration of the best engineering thought and experience and not as prescribed by this bill.
>
> At the best, this bill will create a nuisance, open new political jobs to waste tax money and new avenues for petty graft. The bill, if passed, is to go into effect July 1. A hard winter is ahead if the prospective victims do not act quickly and decisively.

▼

POWER Stands for . .

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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DOUBLE CROSS-DRUM BOILERS in Hell Gate Extension

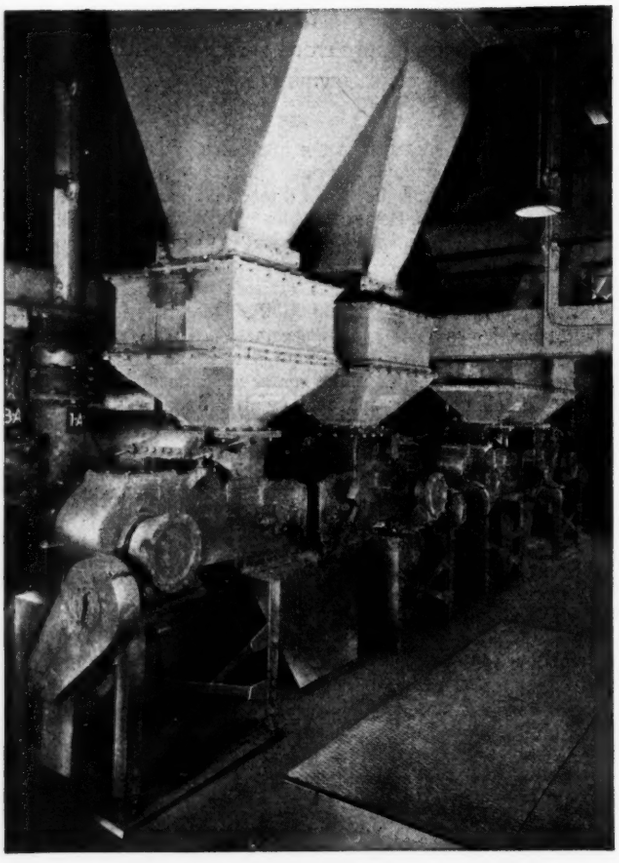


Fig. 1—Coal is fed to each mill by two drag-type feeders

Air-cooled slag bottom furnaces, induced and forced draft fans driven by compound turbines, and pulverizers operating under air pressure instead of suction are features of the new boiler house

▼

AT THE TIME the two 160,000-kw. units were added to the generating capacity of the Hell Gate station of the United Electric Light & Power Company only three additional boilers were added to the steam-producing capacity of the boiler room. Although these three boiler units were the largest that could be installed in the space available in the existing boiler house, they were capable of supplying only about 75 per cent of the steam required by one 160,000-kw. unit.

To provide space for the additional boilers needed to supply steam to the two 160,000-kw. turbines, an extension to the boiler house was erected. This extension had to be built on the side and end farthest from the turbine room and the East River, because of a gas tunnel that had to be avoided and property limitations. The capacity required per square foot of available floor area made necessary a building considerably higher than the older portion of the station.

The new extension houses two boiler units each designed for a nominal output of 800,000 lb. of steam per hour at 275 lb. pressure and 750 deg. The fans and coal-burning equipment were installed with the expectation that each unit would generate 1,000,000 lb. of steam an hour, which expectation was justified during preliminary operation.

Crushed coal for the new boilers is taken from the distributing system of the old boiler house, but due to the increased elevation of the new section, new conveying equipment was required to elevate the coal about 25 ft. above the old narrow-gage track and car-distribution system. A receiving bunker of 175 tons' capacity was placed under the tracks of the old system so that the coal cars could dump directly into it. This bunker discharges to either of two inclined belt carriers A_1 and A_2 in Fig. 5. These belts discharge over magnetic pulleys to an inclined belt B which is also equipped with a magnetic pulley to insure the removal of tramp iron that may have passed the first set of magnetic separators. At the discharge of conveyor B is a shaking screen designed to catch non-magnetic tramp material. The shaking screen discharges to a long belt C having both inclined and horizontal sections. This belt passes over one set of new bunkers distributing coal through a dou-

EACH PRODUCE 1,000,000 LB. OF STEAM AN HOUR

ble-spout tripper. The top of the bunkers, each of 350 tons' capacity, is protected by grizzlies.

In the inclined section of belt conveyor *C* is a scale that weighs and integrates the coal delivered to the new section. The integrated weight is recorded by a counter on the boiler control board. The tripper may be placed so as to deliver coal to a cross belt conveyor *D* which, in turn, discharges to the horizontal belt *E* that distributes through a single-spout tripper to the other set of two new bunkers each of 175 tons' capacity. All of the belts have a designed capacity of 300 tons per hour.

Each bunker supplies coal to two mills located on the boiler house basement floor. The coal is weighed on its way to each mill ahead of the mill feeders and the weight is indicated by counters on the boiler control board.

There are two feeders of the drag-conveyor type for each mill. They are placed on the operating floor along the front and back of the boilers. The speed of the direct-current motor drives, and, therefore, the coal feed, is regulated by two motor-generator sets under combus-

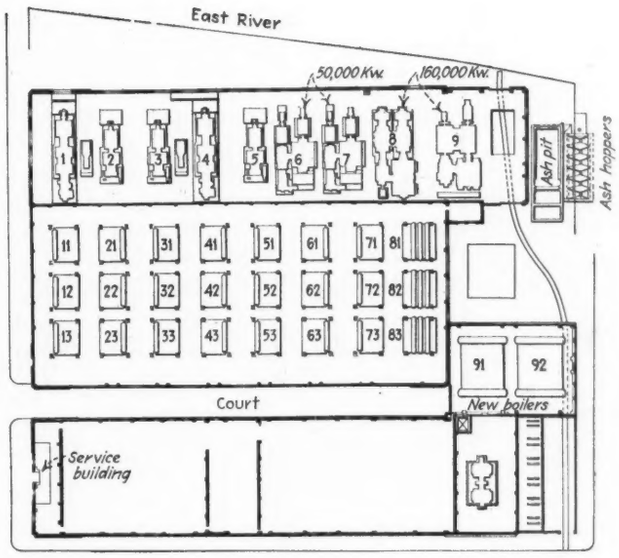


Fig. 3—Plan showing location of new boilers with respect to the old boiler house

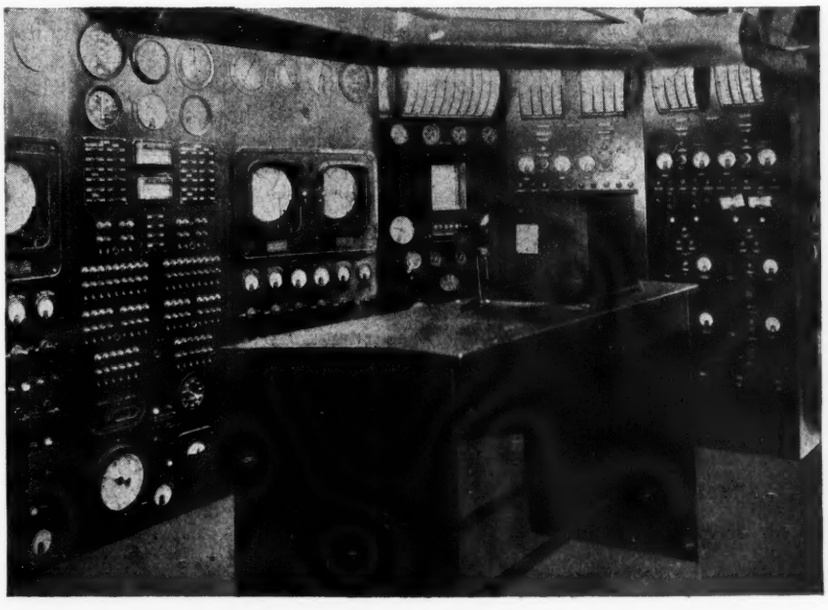


Fig. 2—The controls and instruments for one boiler are mounted on the panels shown

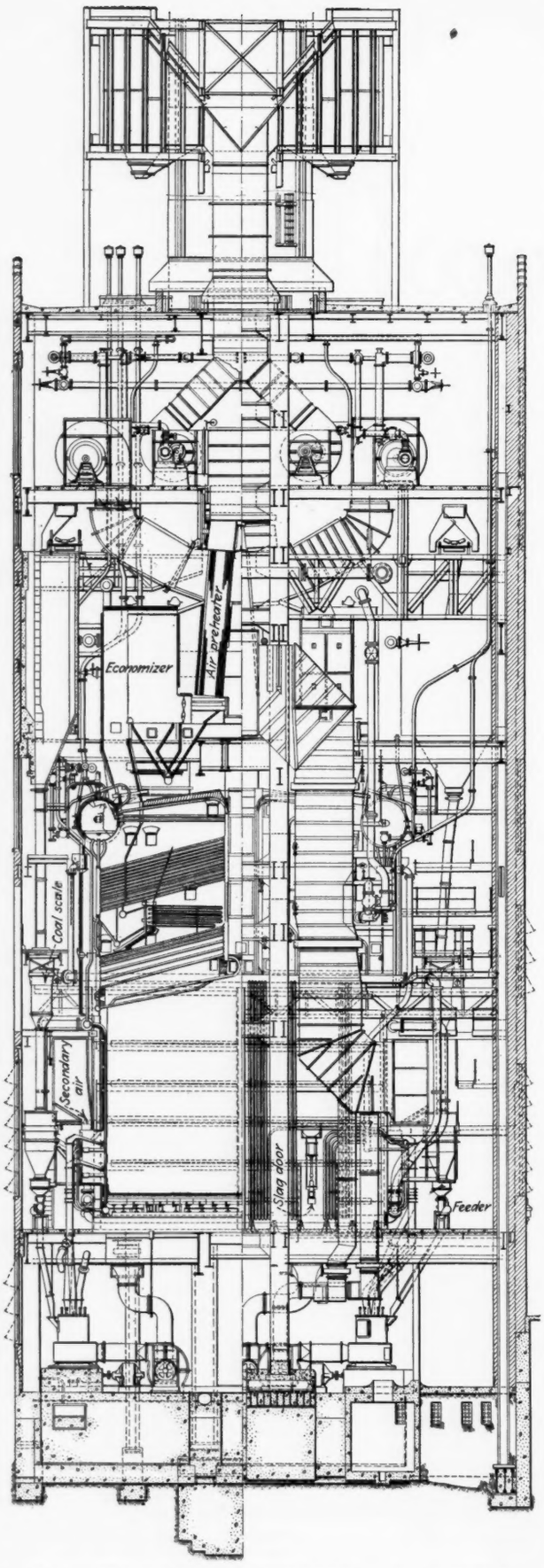


Fig. 4—This double cross-drum boiler has produced over a million pounds of steam an hour

tion control (Ward Leonard voltage control system). The control is arranged so that if one motor-generator set shuts down the remaining unit will increase the speed of the remaining half of the mill feeders until they carry the load. Design load, 800,000 lb. per hour, can be carried with only half the feeders in operation.

Part of the new boiler house extends over a roadway, as shown by the plan Fig. 3. At the basement elevation this roadway had to be kept open in order that the rotor of a frequency changer might be removed if necessary. Because of this the pulverizers were installed approximately under the two boilers as shown in Fig. 6. There are eight mills, four per boiler, of ten tons' nominal capacity each. They are of the improved table type in which the rotating table operates between the two races of grinding balls. Air separation is employed, but the primary fans are placed on the inlet side of the mills, which therefore operate under pressure. This arrangement eliminates the wear on fan blades which occurs when the fans are located so that they handle both air and coal. The primary fans draw preheated air from the secondary air ducts, the connection to the duct being made well back from the burners to eliminate the possibility of sparks getting into the pulverizer. Dampers controlling the primary air to the fans are manually operated from a desk in front of the control boards by means of cables. Indicators show the amount of opening.

There are twelve Calumet inter-tube type burners per boiler, six front and back, placed in two rows about 4 and 8 ft. above the furnace floor. Each mill delivers coal to one row of three burners. Each coal burner is provided with one oil burner for starting purposes.

The water-cooled furnace has a volume of 45,100 cu.ft. and is designed for a heat liberation of 24,600 B.t.u. per hour when the boiler is evaporating 800,000 lb. of steam an hour. Molten ash collecting on the furnace bottom is periodically withdrawn through two 6-in.-wide slag openings in the side walls. As the molten slag issues from these spouts jets of water under 200 lb. pressure impinge against back and front of the slag stream. The water solidifies the slag and breaks it up into small granules. In this form it is carried out of the plant by the station ash-sluicing system. Hydraulically operated gates are provided for stopping the slag flow. In normal operation, however, the slag opening is plugged with refractory clay.

The furnace bottom is a few feet above the operating floor and is of air-cooled construction. Air is admitted through the bottom by a number of pipes extending through the lower layer of refractory to a porous layer of chrome ore, which conducts it horizontally to the wall, where it enters the furnace. Above the chrome ore layer there is a layer of 4-in. thick finely crushed magnesite impervious to air passage. This air constitutes about 2 per cent of the air supplied to the furnace and not only cools the bottom, thus preventing objectionable heat loss to the room, but also cools the refractory above the air passage enough to give it long life.

The cooling air is furnished at about 1 lb. pressure from one centrifugal compressor for each boiler. A spare unit is installed so that it can serve either furnace bottom. Metering orifices and manometers are provided so that the amount of air supplied can be intelligently regulated.

The two boiler units each consist of two cross-drum boilers placed back to back over a single furnace. They are not interconnected, circulation in each being entirely separate. Steam from each drum is delivered

through tubes to separate superheaters. The superheater discharge headers have boiler stop and check valves at both ends, so that steam is delivered from the unit through four 12-in. diameter outlets.

Each boiler of the unit serves one-half of the water walls, one serving half the side walls and back, the other serving half the side walls and front wall. The water wall tubes are protected by refractory-covered metal blocks for 13 ft. above the floor. The next 3 ft. of the wall is covered with rough bare-metal blocks. The water walls are backed with plastic cement and 2½ in. of 85 per cent magnesia and transite casing.

With the boilers placed back to back it became something of a problem to protect the return sectional headers and prevent furnace gas from passing up between them. By bending the bottom tubes so they enter the header from the back, as shown in the cross-section, a support was formed for protecting refractory tile. In addition, the tubes of the first row were bent so that every other tube is lower than its neighbor, thus forming a slag screen.

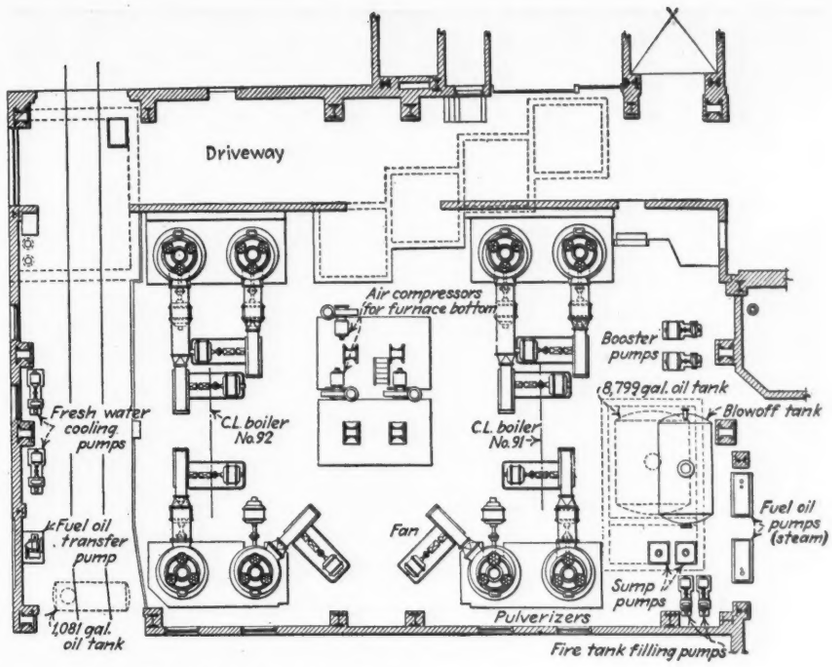


Fig. 6—The 10-ton pulverizers are located under the boilers they serve

Gas from the boilers passes through economizers and air preheaters, each unit having two economizers and two air preheaters. The economizers have 2-in. tubes 30 ft. long and together have a total surface of 19,604 sq. ft. The air preheaters are of the tubular type, with 2½-in. diameter tubes containing a total of 60,500 sq. ft. of heating surface. The preheaters were inclined to permit of having a common plenum chamber for gas outlets, thus enabling the operation of both halves of the boiler unit with a half fan capacity.

There are four induced-draft fans per boiler unit, each of 125,000-c.f.m. capacity at 17 in. static pressure, and two forced-draft fans, each of 150,000-c.f.m. capacity at 11½ in. pressure. These units are divided into two groups. The high-pressure element of a cross-compound turbine drives two induced-draft fans through reduction gearing. The low-pressure element of the turbine drives one forced-draft fan, also through reduction gearing. Crossover piping permits of operating either low-pressure turbine on exhaust from either of the high-pressure elements.

The compound-turbine unit has a total rating of 1,367 hp. Division of load between the high- and low-pressure turbine elements, and, therefore, speed control of the forced-draft fan, is controlled by nozzles in the inlet of the low-pressure turbine. Shutting off nozzles on the low-pressure turbine raises the back pressure on the induced-draft fan turbine, and for the same steam flow decreases the output of the high-pressure element. The inlet pressure on the forced-draft turbine is increased, and therefore its speed increases. Operation of these units is normally under combustion control, but manual operation from the boiler control board has been made possible by remote control equipment.

The turbine drives exhaust at variable back pressures, which at full load is about 25 lb., to a closed heater that heats feed water under boiler feed pressure from about 190 deg. to 255 deg. at full load. At design load the economizers raise the feed temperature to about 330 deg. Each boiler drum is fed at both ends, the water

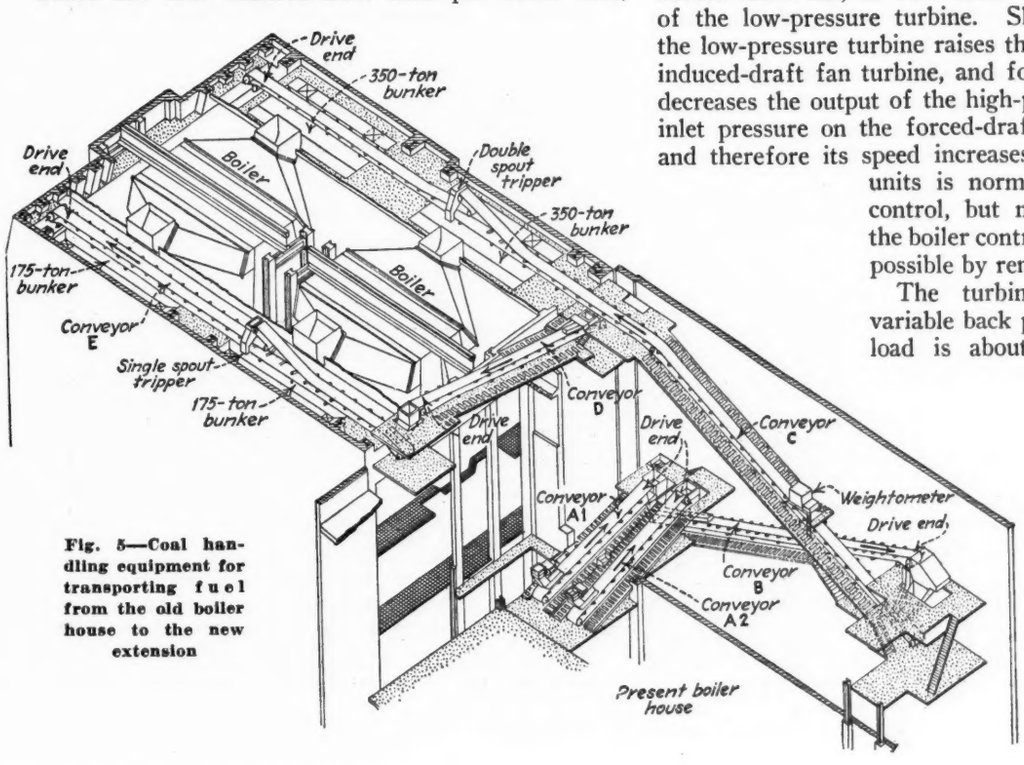


Fig. 5—Coal handling equipment for transporting fuel from the old boiler house to the new extension

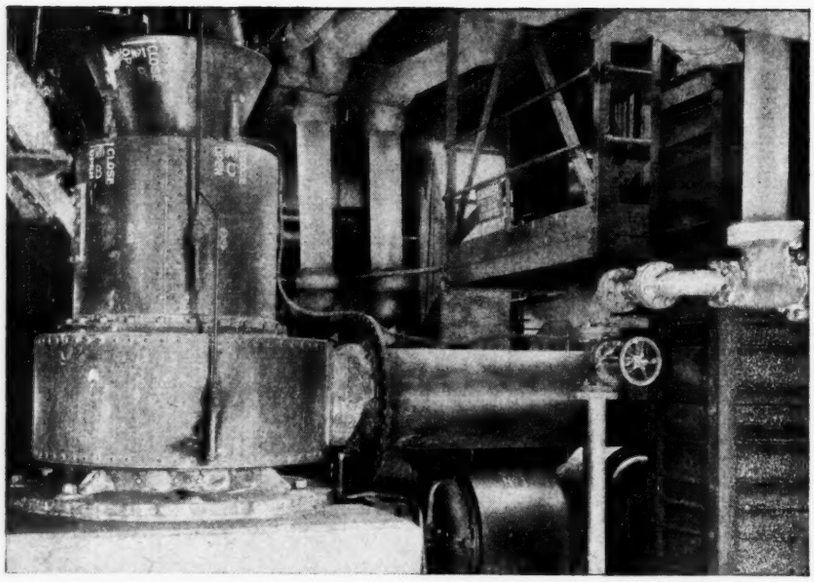


Fig. 7—Preheated primary air blown into the mill carries coal to three burners

first passing through a pressure differential valve and then splitting to water-level-regulating valves at each end of the drum.

Boiler control panels for both boilers form a semi-circular board in front of, and between, the two units. They contain remote-control push buttons, ammeters, pressure gages, draft gages, boiler meters and combustion-control master gages. From this central control board the coal mills, feeders and primary air fans can be started and controlled and all information necessary for efficient operation of both units observed. Induced and forced-draft fans can be controlled, but not started, from the control board, it being necessary to signal the attendant on the fan floor to open the turbine throttles.

Equipment Data, Hell Gate Additions

Coal Handling Equipment

Bunker under old car distribution system, capacity, tons..175
Belt conveyors, six, for elevating and distributing to new bunkers, 300 ton per hr. capacity at 320 f.p.m. Two inclined belts 37 ft. 8¾ in. between head pulleys, elev. 11 ft. 3 in. One inclined belt 99 ft. 3 7/16 in. between pulleys, elev. 30 ft. 5⅜ in., one belt with 98 ft. 2 5/16 in. inclined run, elev. 31 ft., horizontal run 121 ft. 11¼ in. One transfer belt 55 ft. 9⅝ in. between pulleys, elev. 9 ft. 9 in. One horizontal belt 103 ft. 11¼ in.....Sprout Waldron & Co.
Magnetic separators, three.....Magnetic Mfg. Co.
Bunkers, four, two of 175 tons', two of 350 tons' capacity.
Vibrating screens .....Sprout Waldron Co.
Grizzlies, over each bunker.
Pulverizers, eight, four per boiler, type B, table mills, 10 tons' per hr. capacity, driven through gears by 150-hp., 720-r.p.m., 2,200-volt squirrel cage motor..Fuller Lehigh Co.
Mill feeders, two per mill, drag conveyor type, driven by 3-hp., 500 to 2,250-r.p.m., d.c. motor under Ward Leonard control .....Fuller Lehigh Co.
Pulverized-coal burners, 12 per boiler, Calumet inter-tube, each burner rated at 93,000,000 B.t.u. per hr., Fuller Lehigh Co.
Boilers, two, each consisting of two cross-drum boilers set back to back over a single furnace, 18 tubes high, 58 high, 4 in. dia. tubes, 20 ft. long; drums 72 in. dia. 40 ft. 9 in. long, 1⅞ in. thick; total surface per boiler unit, 52,306 sq. ft.; designed for operation at 285 lb..Babcock & Wilcox Co.
Superheater, convection type, two per boiler unit; total surface, 12,000 sq.ft.; steam temperature, 750 deg., Babcock & Wilcox Co.
Economizers, two per boiler, each 24 tubes wide, 26 tubes high; 2 in. dia. tubes, 30 ft. long; total surface per boiler, 19,604 sq.ft. .....Babcock & Wilcox Co.
Water walls, surface per boiler unit, 4,590 sq.ft., tubes protected with Bailey refractory, smooth and rough-metal blocks; furnace volume, 45,100 cu.ft.; heat liberation, 24,600 B.t.u. per cu.ft. per hr.....Babcock & Wilcox Co.
Furnace bottom, slag type, air cooled..Babcock & Wilcox Co.
Air preheaters, four, two per boiler unit; tubular type, 28 rows of 75 tubes 2½ in. dia., 22 ft. long; surface per boiler unit, 60,500 sq.ft.....Babcock & Wilcox Co.
Water columns, two on each drum....Babcock & Wilcox Co.
Soot blowers, valve in head, 48 per boiler unit, 48 in. economizers per boiler unit; two sliding type in each air heater .....Diamond Power Specialty Corp.
Ash-sluicing system .....Allen-Sherman-Hoff Co.
Induced-draft fans, eight, four per boiler unit, each 125,000 c.f.m. at 17 in. static pressure, gas 350 deg., 1,322 r.p.m. .....Buffalo Forge Co.
Forced-draft fans, four, two per boiler unit, each 150,000 c.f.m. at 11½ in. static pressure, air 100 deg., 888 r.p.m. .....Buffalo Forge Co.
Fan drives, four cross-compound Ljungstrom axial flow turbines; each high-pressure element drives two induced-draft fans through reduction gear, 974 hp., 7,500 r.p.m., designed for initial pressure 265 lb., back pressure 75 lb.; each low-pressure element drives one forced-draft fan through reduction gear, 393 hp., 6,000 r.p.m., designed for 75 lb. pressure, 35 lb. back pressure...B. F. Sturtevant Co.
Primary air fans, 18 in. static pressure; driven by 75-hp. motor, 1,200 r.p.m., 2,200 volts.....B. F. Sturtevant Co.
Centrifugal compressors for slag bottom cooling, three 7,100 c.f.m. at 1.25 lb. pressure at 80 deg. F., driven by 58 hp. motor, 3,600 r.p.m., 2,300 volts.....General Electric Co.
Feed-water heater, closed type, 3,390 sq.ft. of heating surface, raises temperature of water from 190 to 255 deg. .....Foster Wheeler Corp.

Pumps

Heater-condensate pumps, one 300 g.p.m., 450 lb., pressure; 125-hp. 3,600-r.p.m., 2,300-volt G.E. motor, Worthington Pump & Machinery Corp.
Ash-removal pump, two 2,000 g.p.m., 200 lb. pressure, 350-hp., 1,750 r.p.m., Westinghouse motor..Scranton Pump Co.
Cooling-water pump, two 250 g.p.m., 200-ft. head; 25-hp., 1,800-r.p.m., 220-volt G.E. motor, Worthington Pump & Machinery Corp.
Salt-water pumps, two, general service, 350 g.p.m., 125-ft. head, 25-hp., 1,800-r.p.m., 220-volt G.E. motor, Worthington Pump & Machinery Corp.
Sump pumps, one 50 g.p.m., one 200 g.p.m., 30-ft., head G.E., 1½-hp., 1,200-r.p.m., and 5-hp., 1,800-r.p.m., 220-volt motors .....Aurora Pump Co.
Fire pumps, two, 100-g.p.m., 275-ft. head; 20-hp. 1,800-r.p.m., 220-volt, G.E. motor .....Quimby Pump Co.
Oil-transfer pump, one, double-acting duplex, 4x6 in., 50-g.p.m., 40-ft. head; G.E., 2-hp., 1,200-r.p.m., 220-volt motor .....Worthington Pump & Machinery Corp.
Smoot control oil pumps, two, 100 g.p.m., 200 lb. pressure, 8x5x10 in., duplex, steam driven.....Scranton Pump Co.
Fuel-oil pumps, two, 50-g.p.m., 265-lb. pressure 7x4x10 in., duplex, steam driven..Worthington Pump & Machinery Corp.
Air compressor, one locomotive type 100 c.f.m., 100 lb. pressure .....Westinghouse Air Brake Co.

Valves

Boiler stop and check valves, four per boiler, Edward Valve & Mfg. Co.
Feed-water valves and control, eight feed valves, four pressure differential regulators .....Bailey Meter Co.
Safety valves, 4-in. valves, 14 per boiler on drums, 8 per boiler on superheaters..Consolidated Ashcroft Hancock Co.
Blowoff valves .....Consolidated Ashcroft Hancock Co.
Gate valves .....Crane Co.
Globe valves .....Edward Valve & Mfg. Co.
Boiler-feed stop and check valves..Edward Valve & Mfg. Co.
Reducing valves .....Mason Regulator Co.
Relief valves.....Foster Engineering Co., Cochrane Co., Consolidated Ashcroft Hancock Co.
Piping, main-steam, boiler-feed, blow-off, Midwest Piping & Supply Co.
Piping, miscellaneous.....M. W. Kellogg Co., Walworth Co., Grinnell Co., E. F. Keating Pipe Bending & Supply Co.

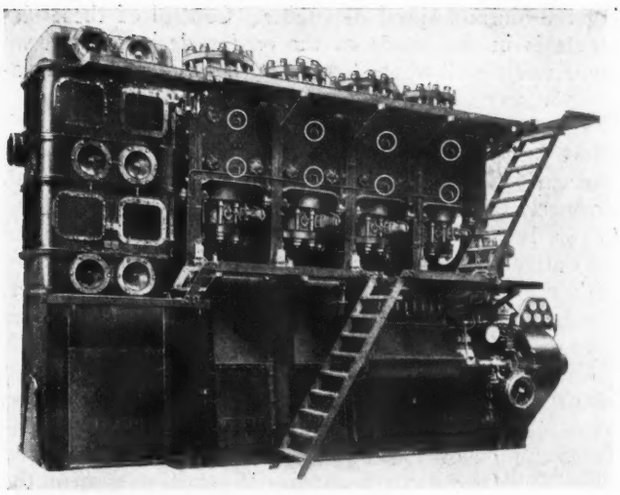
Instruments

Combustion control .....Smoot Engineering Corp.
Steam-flow air-flow meters, two per boiler..Bailey Meter Co.
Feed-water flow meter, recording, integrating and indicating .....Bailey Meter Co.
Pressure gages .....Ashton Valve Co.
Thermometers, indicating..Consolidated Ashcroft Hancock Co.
Draft gages .....Hayes Corp.
Boiler water level indicator.....Brown Instrument Co.
Electric temperature indicators.....Brown Instrument Co.
Tachometers.....Philadelphia Electric Tachometer Co.
Coal-weighing scales, one.....Merrick Scale Mfg. Co.
Eight, one per mill.....Richardson Scale Co.
Ammeters .....Westinghouse Elec. & Mfg. Co.

Miscellaneous

Motor-generator sets, 2, one consisting of a 110-hp. motor, 1,150 r.p.m., driving two 30-kw. generators, and the other a 55-hp. motor, 1,150 r.p.m., driving one 30-kw. generator .....Westinghouse Elec. & Mfg. Co.

Suitability of Fuels for Diesel Engines



By LOUIS R. FORD

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ANY EXTENDED DISCUSSION among diesel engine operators on the subject of fuels will indicate that there are two rather widespread misconceptions as to the types of oil that are suitable for use in such engines. The first of these, that any oil which can be burned is suitable, arises from the ill-advised policy of some who, in their efforts to emphasize the economy of the diesel engine, create the impression that any cheap fuel or any oil that happens to be most available will do.

Some justification for this belief is found in certain isolated cases in which engines have operated on palm oil, whale oil or some other oil that was the only fuel obtainable. An example is the case of a small Alaskan trading vessel, powered with a diesel engine, which some years ago came perilously near being lost in heavy weather by reason of the fuel supply becoming exhausted. When this vessel finally won its way to port the engine was running on fuel composed of a mixture of fuel oil, kerosene, lubricating oil, cup grease, tallow and other oil products the resourceful engineer could find in the ship's stores. Such cases may be regarded simply as stunts and not as criteria for normal diesel operation.

The second misconception, one that is more widely prevalent than the first, is that the lighter the oil the better it is as an engine fuel. The extreme to which this idea may be carried is represented by such cases as that of a small municipal plant serviced by the author in which it was found that the diesel engine was being operated with kerosene. Unsatisfactory performance of the engine had led the plant engineer to use kerosene for fuel in the belief that the very lightest oil obtainable would produce the most satisfactory combustion conditions. Actually it made conditions worse, as it increased such spray-valve troubles as carbon crater formation, premature gasification and leaking. Strangely enough such ideas are not confined to practical engineers who have no technical training, as indicated by the case of a pair of large two-stroke-cycle, double-acting engines that gave a great deal of trouble during the guarantee period. The manufacturer of the engines, under whose supervision they were operated during this period, insisted upon the use of a grade of fuel hardly more viscous than kerosene. Many of the combustion difficulties experienced as a result disappeared when a heavier grade of fuel was used.

Another large, air-injection engine that came under the writer's observation was operated with a light fuel oil supplied by one of the large oil companies as standard diesel fuel. Starting with all operating conditions normal, first one cylinder, then another would stop firing, and in every case examination of the spray valves showed the holes in the spreader plates to be blocked by outside carbon craters. After heavier fuel oil was substituted, with no change in engine adjustment other than cleaning of spray valves, no further trouble was experienced. Without attempting to analyze the action of the light fuel, the evidence was conclusive in this case that the operating trouble was due to unsuitable fuel.

If the matter of viscosity were the only fuel factor influencing engine performance it would be easy to determine just what range of viscosities would be permissible and establish a standard for judging the suitability of fuels. Unfortunately there are a number of other factors, some known and others unknown, which exert a marked influence on combustion. It has been found in attempting to develop standard specifications for diesel fuel that the established forms of specifications, based on physical characteristics, are not adequate for designating a satisfactory oil. A number of fuel oils may be found to conform exactly to the same specifications and yet behave entirely different in any one engine.

For several years the Fuel Oil Research Committee of the A.S.M.E. has been working on the problem of determining just what factors do control the combustion performance in any diesel engine. The several progress reports made by this committee disclose several interesting things. The controlling factors are divided into two groups, which may be called engine factors and fuel factors. The first group is fairly definitely known and includes such things as compression, shape of combustion chamber, volume of air compressed, means for spray-

ing the oil, and speed of engine. Control of these elements is in the hands of the engine designer, and we know fairly well what effects may be produced by variations in any of them.

The second group is not so well known, and research effort is being directed toward finding out just what characteristics in any oil make it a good or a bad fuel. Formerly viscosity was thought to be the controlling factor, because of the fact that low viscosity permitted easy atomization of the fuel and more complete mixing with the air, while high viscosity made these harder. We have, however, learned that although viscosity does have an influence there is something else that controls.

Carbon content seemed to have an influence, and investigations were made to determine just what carbon content, as measured by the Conradson method, fixed the oil as a good or a bad fuel. Some tests, if considered alone, indicated that the higher the carbon content the worse the behavior of the fuel; but other tests indicated that radical differences in performance could be expected from some oils in which the carbon content aproached the vanishing point.

Ignition Point Must Be Considered

A factor that gives indications of important, perhaps controlling, influence is the ignition point of the oil, the temperature at which ignition will begin in the cylinder.

A great many tests have been made by different investigators for the purpose of measuring the ignition point of various oils, but little has been accomplished in the way of the relating ignition point to engine performance. It remains to be determined what ignition point is best. When this is determined, what effect on ignition point will the degree of atomization have, or the compression or shape of combustion chamber?

A factor that seems to be important is the rate at which the fuel burns after ignition occurs. It is possible that for a given engine condition there may be a direct relation between ignition point and rate of burning. As a side light on this question of influence of ignition point and rate of burning on engine performance, and their relation to each other, it is interesting to note that when the tetraethel lead method of treating gasoline to give it anti-knock qualities was introduced it was thought that the effect of the lead was to raise the ignition point. Yet it was found that benzol added to the gasoline also gave it anti-knock qualities, although benzol actually lowered the ignition point.

After research has discovered what it is that controls the behavior of fuel in the engine cylinder, so that definite specifications can be prepared that will give us oils having uniform and constant performance characteristics, a serious and difficult problem will then be presented to the oil chemists. That problem will be to discover how a material so complex as petroleum can be processed to make it conform to such specifications.

No Universal Specification

The situation now is that there is a marked difference in the characteristics of oils from different localities, even though these localities may be geographically near each other. Even if the total supply of any one kind of oil was large enough to warrant completely separate handling, refining and marketing, the result would be a "tailor made" product the price of which would be prohibitive. The supply of oil products to meet the world's demand is manufactured from crude stocks accumulated from many different sources, large and small, and mixed together. Certain separations can be made, such as the asphalt-base oils from the parafine-base oils, but each of these contains many varieties of oils. Added complexity is due to the fact that variations in refinery practice, type of stills used, etc., have an influence, sometimes not definitely known, on the characteristics of the products.

There is no specification in existence that will produce an unvarying quality of fuel oil, and there is no doubt that many engine operation defects that are the source of trouble, annoyance and ill feeling are caused by fuel oil that is apparently above suspicion. An interesting example of this is found in the case of a six-cylinder, four-stroke-cycle, solid-injection engine operated by a well-known oil company. An apparently good grade of fuel oil of low viscosity and low carbon content was used and gave very satisfactory operation at full load. When it was desired to operate at light load, firing of all cylinders could not be obtained and a great deal of black smoke appeared in the exhaust. There was no reason to suspect the fuel oil and it was assumed that the fault was in the engine, but every effort to adjust it to obtain good fractional load operation proved unavailing.

The engine had performed well in all respects on the test stand, and when representatives of the builder were called in they anticipated no difficulty in making it duplicate that performance. When all their efforts failed, a trial was made with some of the same oil that was used in the shop tests. Satisfactory operation at all loads was obtained with this oil.

Since both oils had been supplied by the owners of the engine and both conformed to the same specifications, the situation was sufficiently interesting to call for confirmatory tests. Repeated tests proved the first oil to be a poor fuel and the second to be good. Tests were then made by mixing the oils in gradually varying proportions, and it was found that mixtures containing up to one-fourth of the first oil and three-fourths of the second worked satisfactorily. This mixture was used with good results for some time; then the bad conditions suddenly occurred again. Investigation showed that the inception of the trouble coincided with the time of a change in still operation in refining No. 1 oil.

Originally thermo-syphon circulation was used in the still, but to obtain greater production the method was changed to pump circulation. This increased the rate of heating and the output of still, but apparently it also did something to the oil that changed its combustion characteristics in the engine.

In this case high-grade engineering supervision and intelligent co-operation between engine owner and engine builder, combined with the fact that the owner was also the producer of the fuel oil, served to trace the trouble far enough toward its source to absolve the engine from blame. The obscurity of the factors in the oil that influ-

ence its combustion performance, and the fact that no one knows yet just what to put into an oil specification to fix these factors and permit the development of refinery procedure with which they can be controlled, show clearly the folly of attempting to establish a standard oil specification by the popular vote method, as has been done in the past.

In conclusion, it can be said that the oil refiners are as willing to produce a good diesel fuel as the engine users are anxious to have one. The best the engine user can do under present conditions is to depend on actual performance in the engine to find out what diesel fuel best suits his particular operating conditions. The obvious difficulty in cases of unsatisfactory operation lies in the definite separation of troubles due to the engine from those due to the fuel.

Waste-Heat Boilers For New Steel Plant

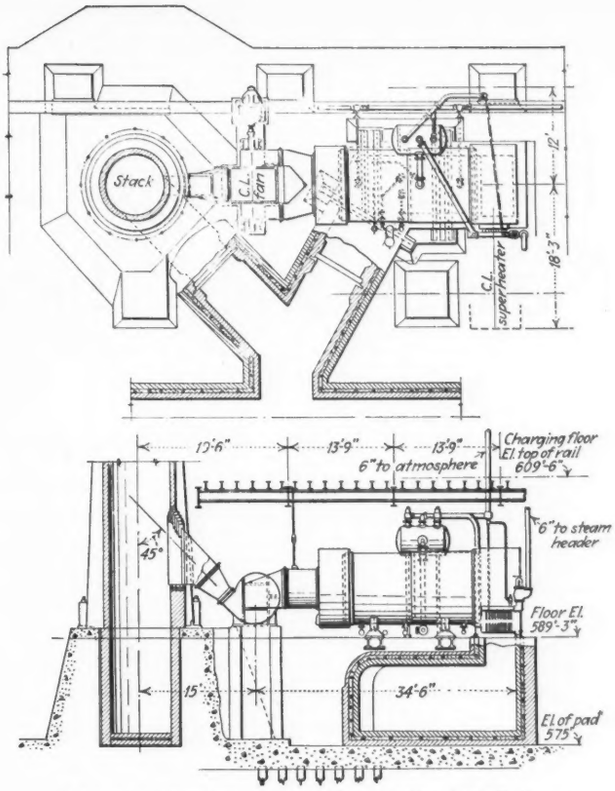
IN PROJECTING a new open-hearth steel plant, adequate and economical recovery of heat from furnace gases is a problem open to a number of solutions. For example, the relative values of air preheaters and waste-heat boilers are debatable, and there is a possibility of retaining the open-hearth furnace solely as a steel-producing unit, returning to the furnace whatever heat may be available in the stack gases.

In the new steel plant of the Great Lakes Steel Corporation, at Ecorse, Mich., waste-heat boilers were selected. The open-hearth shop at this plant comprises six furnaces nominally rated at 150 tons' capacity each, and designed for firing with fuel oil. Provision has been made for the possible future use of producer gas in the furnaces and space allowed for the producers.

A study of the process-steam requirements indicated an excess of steam available from waste heat. As the mills and auxiliary equipment are driven on purchased power, the installation of a direct-fired boiler plant was not considered, since higher investment cost and greater operating expense would have been entailed. The possibility of selling surplus steam to an adjoining industry made the installation of waste-heat boilers additionally attractive. So each furnace was equipped with a waste-heat boiler of Freyn design, horizontal, single-pass, fire-tube type, each boiler having 6,000 sq.ft. of heating surface and built for a working pressure of 150 lb. gage.

The furnaces were designed of ample capacity to permit tapping 180-ton heats if necessary. On the 150-ton heat basis and with oil fuel, the estimated quantity of waste gases amounts to 90,000 lb. per hour; with producer gas as fuel, 100,000 lb. per hour. Similarly, the quantities for 180-ton heats for oil or gas fuel are 108,000 and 120,000 lb. per hour, respectively. As a consequence, the waste-heat boilers and auxiliary equipment were designed to handle this range in gas flow, that is, 90,000 to 120,000 lb. per hour, with an expected gas temperature of 1,000 deg. F. Under these conditions each boiler is expected to produce 14,800 to 17,600 lb. of steam per hour with the furnaces operating on oil fuel.

It will be recalled that the Freyn boiler is designed to make use of the well-known property of hot gases to most effectively transmit heat by convection at high gas velocities. It has the advantage of being immune to air infiltration, and the space required is comparatively small. In the present installation, the entire unit is under the charging floor. The boiler shells are 9 ft. diameter and 18 ft. long over the heads. They are supported on floor saddles which rest upon steel girders spanning the underground gas flue. The boiler fronts are extended to form steel-incased intakes for the hot gases, and are brick-lined.



Plan and elevation of waste-heat boiler installation

To provide accessibility for cleaning and inspection, superheaters are located just above the floor line in the gas intake housings of the boilers. They are of the bare tube type, with double-loop elements arranged horizontally and supported centrally by a brick arch to prevent sagging. As dry steam is required for atomizing the oil at the burners, under normal operation the steam will be superheated 100 deg. F.

The induced-draft fans are of the double-inlet steel-plate type, with the inlet boxes joined to the rear smoke box of each boiler by short "Y" connections. As will be seen in the illustration, the fans discharge directly into the stacks through nozzles riveted to the lower cone sheets. Regulation of draft is secured through variable-speed control of the fan motors, which operate on direct current, there being a 50 per cent speed reduction ratio.

In planning this installation, the Freyn Engineering Company, of Chicago, found it possible to provide a direct line of gas travel. The underground flues are short, and the gases, upon reaching the inlet housings of the boilers, have straight-line flow to the stacks. All parts of the waste-heat boiler units are above the ground floor level and no part above the charging floor.

Two of the waste-heat boiler units have been in operation for two or three months, during which time the furnaces were being fired for making bottom, only recently starting to produce steel. Other units will be placed in service as requirements for steel increase.

The Economical Design of Natural-Draft Chimneys

For the practical use of plant designers and operators the author here presents rational formulas for chimney proportions including cost as well as all physical factors that affect the problem. Charts and a table permit rapid determination of most economical size of natural-draft chimneys for typical atmospheric and temperature conditions. The basic formulas presented are applicable to any conditions

By J. G. MINGLE

Amount of Gases Flowing, in Lb. per Sec.	Required Draft at Breeching Entrance, Ins. of Water.												
	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6
	Economical Size of Chimney												
5	75 3.5	95 3.5	115 3.5	135 3.5									
10	75 4.0	95 4.0	115 4.0	135 4.0	150 4.0								
15	75 4.5	95 4.5	115 4.5	135 4.5	150 4.5	170 4.5	190 4.5						
20	75 5.0	95 5.0	115 5.0	135 5.0	150 5.0	170 5.0	190 5.0						
25	75 5.5	95 5.5	115 5.5	135 5.5	150 5.5	170 5.5	190 5.5						
30		95 5.5	115 5.5	135 5.5	150 5.5	170 5.5	190 5.5						
35		95 6.0	115 6.0	135 6.0	150 6.0	170 6.0	190 6.0	210 6.0					
40		95 6.5	115 6.5	135 6.5	150 6.5	170 6.5	190 6.5	210 6.5					
45		95 6.5	115 6.5	135 6.5	150 6.5	170 6.5	190 6.5	210 6.5					
50			115 7.0	135 7.0	150 7.0	170 7.0	190 7.0	210 7.0	230 7.0				
60			115 7.5	135 7.5	150 7.5	170 7.5	190 7.5	210 7.5	230 7.5				
70					150 8.0	170 8.0	190 8.0	210 8.0	230 8.0	250 8.0	270 8.0	290 8.0	310 8.0
80					150 8.5	170 8.5	190 8.5	210 8.5	230 8.5	250 8.5	270 8.5	290 8.5	310 8.5
90						170 9.0	190 9.0	210 9.0	230 9.0	250 9.0	270 9.0	290 9.0	310 9.0
100						170 9.5	190 9.5	210 9.5	230 9.5	250 9.5	270 9.5	290 9.5	310 9.5
110						170 9.5	190 9.5	210 9.5	230 9.5	250 9.5	270 9.5	290 9.5	310 9.5
120						170 100	190 100	210 100	230 100	250 100	270 100	290 100	310 100
130						170 105	190 105	210 105	230 105	250 105	270 105	290 105	310 105
140						170 105	190 105	210 105	230 105	250 105	270 105	290 105	310 105
150						170 110	190 110	210 110	230 110	250 110	270 110	290 110	310 110
160						170 110	190 110	210 110	230 110	250 110	270 110	290 110	310 110
170						170 115	190 115	210 115	230 115	250 115	270 115	290 115	310 115
180						170 120	190 120	210 120	230 120	250 120	270 120	290 120	310 120
190							190 120	210 120	230 120	250 120	270 120	290 120	310 120
200							190 125	210 125	230 125	250 125	270 125	290 125	310 125

MINGLE'S TABLE OF ECONOMICAL SIZES FOR NATURAL-DRAFT CHIMNEYS

Based on: 62 deg. F. atmospheric temperature, 500 deg. F. chimney gas temperature, 0.09 chimney gas density, 0.016 coefficient of friction, sea level elevation.

IT HAS BEEN the usual custom, and still is to a lamentably great extent, to select the required size of a natural-draft chimney from a table of chimney sizes based only on boiler horsepowers. After the ultimate horsepower of the projected plant had been determined, the chimney size in the table corresponding to this figure was then selected as the proper size chimney. Generally, no further attempt was made to determine if the height thus selected was sufficient to help create the amount of draft demanded by the installation, or the diameter sufficiently large to enable the chimney to quickly and efficiently dispose of the gases.

The operating characteristics of a natural-draft chimney are similar in all respects to those of a centrifugal pump or a fan, and it is no more possible to select a proper size chimney from such a table, even with correction factors appended, than it is to select the proper size pump or fan from tables based only on the amount of water or gases to be accommodated. Just as it is necessary to know, in addition, the total dynamic head and static pressure against which a centrifugal pump and a fan, respectively, are to operate, so it is necessary to know the total required draft against which the chimney is to operate.

Speaking in general terms, the height of a properly designed natural-draft chimney is dependent upon the amount of draft required to overcome the various losses of draft throughout the entire installation, or such part of it as the chimney is to serve, and the area upon the total amount of gases generated and passed on to the chimney. It is the purpose of this article to develop a system of arriving at the most economical size of chimney and at the same time take into consideration all of the various operating factors that affect the size in one way or another.

The general equations for the height and diameter of a

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round natural draft chimney may be stated as follows:

$$H = \frac{D_r}{2.96\,B_o\left(\frac{W_o}{T_o} - \frac{W_c}{T_c}\right) - \frac{0.184\,f\,W_c\,B_o\,V^2}{T_c\,D}} \quad (1)$$

$$D = 0.288\sqrt{\frac{W\,T_c}{B_o\,W_c\,V}} \quad (2)$$

H = Height of chimney above grate bars, ft.
D = Minimum internal diameter, ft.
D_r = Required draft, or sum of various losses of draft (including loss of draft due to velocity) throughout the entire boiler plant installation outside of the chimney itself, in. of water.
B_o = Atmospheric pressure corresponding to altitude, in. of Hg.
W_o = Density of atmosphere at 0 deg. F. and sea level barometer, lb. per cu.ft.
W_c = Density of chimney gases at 0 deg. F. and sea level barometer, lb. per cu.ft.
T_o = Atmospheric temperature, deg. F. abs.
T_c = Chimney gas temperature, deg. F. abs.
f = Coefficient of friction.
W = Amount of gases flowing and being discharged, lb. per sec.
V = Chimney gas velocity, ft. per sec.

These two equations give the height and diameter of a natural-draft chimney with all of the operating factors taken into consideration. Values for all of the factors, with the exception of the chimney gas velocity, may be either observed or computed. It is, of course, necessary to assume an arbitrary value for the velocity in order to arrive at some definite size. For any one set of operating conditions there will be as many sizes as there are values of reasonable velocities to assume. Of the number of sizes corresponding to the various assumed velocities, there is one size whose cost will be least. Since the cost of a chimney, regardless of the materials used in the construction, varies as the volume of material in the structure, the cost criterion then may be represented by the approximate equation:

$$Q = \pi\,t\,H\,D \quad (3)$$

in which:

Q = Volume of material, cu.ft.
t = Average wall thickness of shaft, ft.
H = Length of shaft, ft.
D = Median diameter, ft.

For all practical purposes, the median diameter may be assumed as equal to the inside diameter of the chimney. The value of t will not vary appreciably within the range of sizes for any one set of operating conditions. Hence the value of πt may be taken as a constant regardless of the size of the chimney. Whence, in general, the volume, and, consequently, the cost, of a chimney may be based on the factor HD as a criterion. Therefore, the value of the chimney gas velocity which will result in the least value of HD for any one set of operating conditions will produce a structure whose cost will be least and, as a result, will be the most economical velocity to use.

The problem at hand is to deduce an equation for the chimney gas velocity which will result in a combination of a height and a corresponding diameter whose product HD will be least. The solution is obtained by equating the product of equations (1) and (2) to HD, differentiating this product with respect to V and equating the

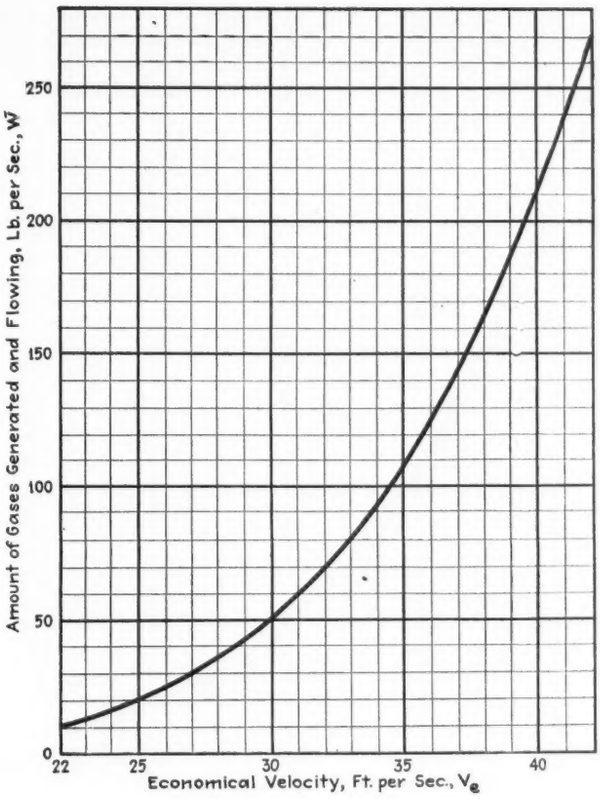

Fig. 2—Values of V_e for various values of W, based on the formula: $V_e = 13.7\,W^{\frac{1}{3}}$

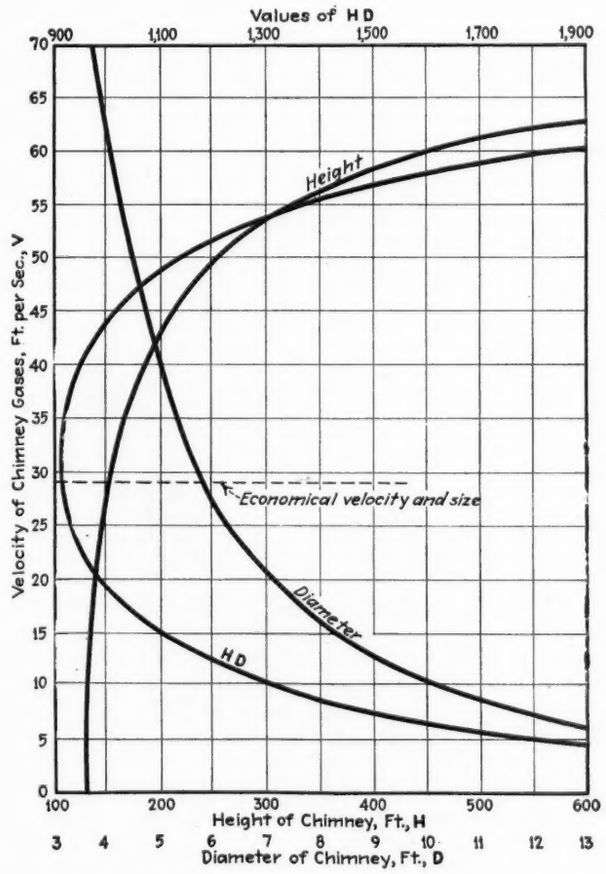

Fig. 1—Variation in values of height, diameter and *HD* for various values of *V*

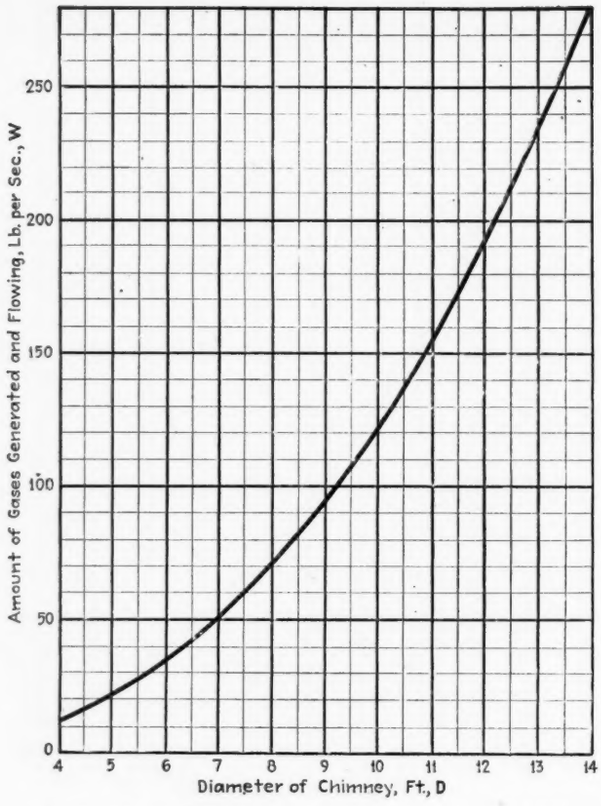

Fig. 3—Values of D for various values of W, based on the formula: $D = 1.47\ W_g^{\frac{3}{8}}$

resulting expression to zero. This procedure results in the following expression:

$$V_e = \left(\frac{0.772\, T_c \left(\frac{W_o}{T_o} - \frac{W_c}{T_c} \right) \sqrt{\frac{WT_c}{B_o W_c}}}{f W_c} \right)^{2/5} \quad (4)$$

in which V_e = economical chimney gas velocity, ft. per sec.

Equation (4) gives the economical velocity of the chimney gases for any one set of operating conditions and represents the velocity that will result in a chimney the size of which will cost less than that of any other size as determined by any other velocity for the same operating conditions.

After the value of the economical velocity has been determined, the corresponding diameter and height can then be determined from equations (2) and (1) respectively.

To illustrate the use of these formulas, assume that it is desired to determine the economical velocity and the corresponding size for the following operating conditions:

1. Mean atmospheric temperature, 62 deg. F., $T_o = 522$.
2. Average chimney gas temperature, 540 deg. F., $T_c = 1{,}000$.
3. Sea level atmospheric conditions, $B_o = 29.92$.
4. Chimney gas density at 0 deg. F. and sea-level atmospheric conditions, 0.09 lb. per cu.ft., $W_c = 0.09$.
5. Atmospheric density at 0 deg. F. and sea level atmospheric conditions, 0.0863 lb. per cu.ft., $W_o = 0.0863$.
6. Coefficient of friction, 0.016, $f = 0.016$.
7. Amount of gases flowing and being discharged, 33 lb. per sec., $W = 33$.
8. Total required draft, or total draft loss, 0.85 in. of water, $D_r = 0.85$.

Substituting these values in equation (4):

$$V_e = \left(\frac{0.772 \times 1{,}000 \times \left(\frac{0.0863}{522} - \frac{0.09}{1{,}000} \right) \times \sqrt{\frac{33 \times 1{,}000}{29.92 \times 0.09}}}{0.016 \times 0.09} \right)^{2/5}$$

$= 28.8$ ft. per sec.

Whence, from equation (2):

$$D = 0.288 \sqrt{\frac{33 \times 1{,}000}{29.92 \times 0.09 \times 28.8}} = 6.0 \text{ ft.}$$

and from equation (1):

$$H = \frac{0.85}{2.96 \times 29.92 \times \left(\frac{0.0863}{522} - \frac{0.09}{1{,}000} \right) - \left(\frac{0.184 \times 0.016 \times 0.09 \times 29.92 \times (28.8)^2}{1{,}000 \times 6} \right)}$$

$= 153$ ft.

Therefore, the economical size of chimney for the operating conditions noted is 153 ft. × 6 ft.

Fig. 1 shows the variation in the diameter and height and also the value of HD for various assumed velocities for the operating conditions assumed in the preceding example. It will be noted that the flexure point of the HD curve is at $V = 28.8$, which indicates the economical velocity and also the economical size, that is, 153 ft. in height and 6 ft. in diameter. All other sizes as determined by all other velocities will cost more than the size determined by $V = 28.8$ ft. per second.

Equations (1), (2) and (4) may be considerably simplified for average operating conditions in an average

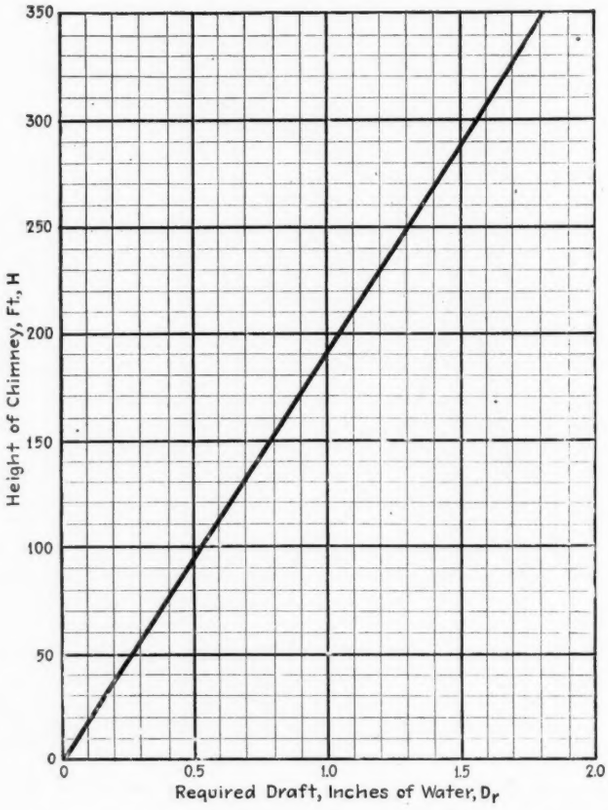

Fig. 4—Values of H for various values of D_r from the formula $H = 191\ D_r$

size steam plant by assuming the following conditions as constant:

1. Average chimney gas temperature, 500 deg. F., $T_c = 960$.
2. Mean atmospheric temperature, 62 deg. F., $T_o = 522$.
3. Average coefficient of friction, 0.016, $f = 0.016$.
4. Average chimney gas density, 0.09, $W_o = 0.09$.
5. Sea level barometer, 29.92, $B_o = 29.92$.

Substituting these values in equations (1), (2) and (4), respectively, and reducing:

$$V_e = 13.7\, W^{1/5} \quad (5)$$

$$D = 1.47\, W^{2/5} \quad (6)$$

$$H = 191\, D_r \quad (7)$$

Figs. 2 and 3 give the values of V and D, respectively, for various values of W, and Fig. 4 the values of H for various values of D_r, as determined from equations (5), (6) and (7), all based on the constant operating factors noted. These three curves may be used generally for determining the required size of a natural-draft chimney in the absence of any definite data as to future operating conditions. Provided proper values are assigned to W and D_r they will give results on the side of safety.

The table on page 364 gives the economical sizes of natural-draft chimneys for various amounts of gases generated and flowing, and required draft intensities at breeching entrance of chimney based on the following assumed operating factors: 62 deg. F. atmospheric temperature, 500 deg. F. chimney gas temperature, sea level atmospheric conditions, coefficient of friction of 0.016, chimney gas density of 0.09 lb. per cubic foot at 0 deg. F. and sea level atmospheric conditions. This table may be used for selecting the economical size of a chimney for a plant that will operate under average conditions where the values of the various factors are not definitely known. When the conditions are definitely known, however, the size should be calculated from equations (1), (2) and (4).

Where Welding Saves Money and Weight

By M. C. COCKSHOTT
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SOME PEOPLE may claim that the looks of a piece of pipe work are improved by the use of fittings, but a well-welded bend does not look at all unworkmanlike. Ease of removal is an argument in favor of the flanged fitting. But this also can be taken care of in the welded bend or tee by the judicious placing of flanged unions. Cost, then, must be the deciding factor in most cases. In this connection the following cost comparisons will be of interest.

Let us take up first the case of a 10-in. cast-iron or 90-deg. bend and its replacement by a welded bend of two 45-deg. joints. Costs of fitting job run as follows:

1 C.I. 10 in., 90 deg. ell, F & D (faced and drilled)	$13.45
2 C.I. 10-in. comp. flanges	5.16
24 ⅞x3½ bolts and nuts	1.30
2 gaskets	0.55
Labor, cutting threads	3.76
	$24.22

The cost of the welded job is that required for cutting and welding two 45-deg. angles. Allowing 1 hr. 25 min. at $2.50 per hour, this gives $3.54.

This weld also requires 5 ft. of 10-in. pipe costing about $8. This cost is not figured in, because practically the same length of pipe is saved on the straight runs to the ell.

If there are two or three bends to be made, the cost of the flanges can be divided among them. The cost of welding has been closely figured at a rate of $2.50 per hour, which includes labor and welding material.

The excess weight of the fitted job in this case is practically that of the flanged ell with companion flanges and bolts. This is about 256 pounds.

Here is another comparison. In making up an air vessel or container of 16-in. pipe the cost of a job fabricated with companion flanges and blind flanges is figured as follows:

2 16x23½ companion flanges, F & D	$14.40
2 16x23½ blind flanges, F & D	20.48
2 gaskets	1.40
32 1x4½ bolts and nuts	2.50
Labor, cutting threads, etc	9.25
	$48.03

The corresponding cost of a welded job with orange-peel head would be:

Cutting and welding 2 orange-peel heads; 2 hr. 45 min. at $2.50	$6.87
About 2 ft. of 16-in. pipe for heads	9.00
	$15.87

Comparative weights are:

Weight of flanges, etc., lb.	264
Weight of heads, cut from pipe, lb.	75

Next comes the case of a nipple welded into a line, thus doing away with a reducing tee or straight tee. The costs of a flanged job are as follows, assuming a 6-in. stub joined to an 8-in. line:

1 8x8x6 C.I. Red. tee, F & D	$13.88
2 C.I. 8x13½ companion flanges, F & D	3.56
2 gaskets	0.40
16 ¾x3½ bolts	0.50
Labor on two threads, etc	3.00
	$21.34

A welded job would run as follows:

Cutting and welding stub 6 in. into 8-in. line, 40 min. at $2.50 per hr	$1.66
12 in. of 6 in. pipe	1.00
	$2.66

From actual time checks of welding it is found that the following are fairly accurate costs on welded pipe work:

(1) Cutting and welding two flat plates as heads for a fuel storage tank (gasoline engine) made up of 10-in. pipe 1½ hr. at $2.50 (labor and welding material) $3.75

(2) Cutting and welding two pieces of 8-in. pipe, including truing up: 35 min. at $2.50 (labor and welding material) $1.46

(3) Cutting and welding two pieces of 3-in. pipe (including truing up); 25 min. at $2.50 ..... $1.04

These figures have all been arrived at in actual practice in plant engineering and construction, and will give readers a ready means of estimating welding pipe work. The $2.50 per hour allowed for welding covers all costs, including interest and depreciation of equipment, but no profit.

In attaching flanges, the use of flanges with integral necks for butt welding is becoming general. Although these cost a little more, as they are steel the extra cost is practically cancelled by the saving of the cost of threading and seal-welding the threads.

Disk-Arm Pivot Valves Controlled Automatically

Two 96-in. disk-arm pivot valves control the water to the penstock of two 33,000-hp. hydro-electric units operating under a 660-ft. head. These valves are electrically operated and in the case the water through them exceeds a certain limit they will close

By J. ELMER HOUSLEY

Superintendent
Tallassee Power Company

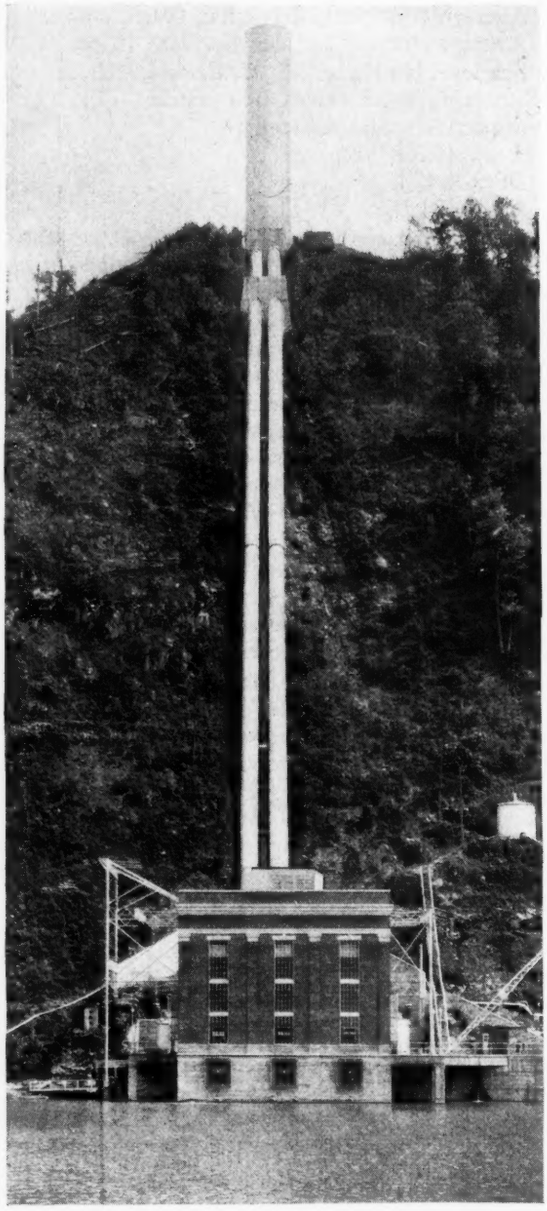
THE Santeetlah power house of the Tallassee Power Company, a subsidiary of Aluminum Company of America, is situated on Little Tennessee River, five miles east of Tapoco, N. C. The two turbines in the power house are each rated at 33,000 hp. and operate under a nominal head of 660 feet.

Of particular interest is the installation of two S. Morgan Smith 96-disk-arm pivot valves to control the water entering two penstocks which extend up the steep hillside above the power house. At the brow of the hill the penstocks become horizontal and connect to the valve casings. On the upstream side the valves connect to a "Y" junction with the 11-ft.-diameter pipe line. Adjacent to the "Y" is the differential surge tank, which rises 165 ft. above its foundation. The valves are five miles from the dam, the water from the reservoir being carried through five tunnel sections and five pipe sections. The center of the valves is at elevation 1,678 ft. and the surface of the reservoir when full is at 1,817, giving a maximum static head of 139 ft. on the valves.

The valve casings are of cast iron with integral flanges. They are heavily ribbed and provided with feet which are secured to the concrete foundation. Two bosses are located horizontally to receive the bronze-bushed bearings for supporting the pivot shaft, which is metallic-packed to prevent leakage. The casing has a babbitt seat for the disk when in the closed position. The leakage is very small around this seat.

The disk of each valve is a one-piece steel casting, and the heavy central portion forms a hub which receives a steel pivot shaft keyed to the disk. The finished circumference of the disk forms a seal with the babbitt seat in the housing when the disk reaches an inclined position of about ten degrees from the vertical center line. The disk has a lug cast integrally which receives the connecting rod from the operating mechanism.

A 25-hp., 220-volt, 750-r.p.m., compound-wound, direct-current motor drives the operating mechanism. A long cast-iron cylinder, bronze-lined, serves as a cross-



The disk-arm valves are located at the upper end of the penstocks near the differential surge tank

head guide on each valve. This cylinder is bolted to the valve casing and is embedded in the concrete bulkhead on the downstream extension to the casing. The crosshead is hemp-packed to prevent leakage of water through the guide cylinder. A steel operating stem extends from the crosshead through the hoisting unit. The operating nut is key-seated for the worm gear and is made of bronze with a standard acme thread. A cast-iron worm gear meshes with a steel worm forged integrally with a shaft which is driven from the motor through reduction gearing.

Loads on the stem due to both opening and closing of the valve are carried on roller thrust bearings, and the axial thrust of the worm is carried on ball bearings. Under the housing a cast-iron guide supports the stem

and is provided with a bronze feather key to prevent rotation of the stem. The housing inclosing the mechanism serves as an oil reservoir for lubrication of the parts. Other parts are provided with fittings for high-pressure grease lubrication.

Each mechanism is provided with limit switches which stop and reverse the direction of travel of the mechanism and serve to insert a resistance in the motor circuit just before the closed position is reached; this reduces the torque and speed of the motor, and the valve is closed under a predetermined torque. A time-limit relay disconnects the motor after the valve has seated. A storage battery normally floated on a motor-generator set operates the motor and controls. The battery and control panels are adjacent to the valve.

The valves may be operated from the near-by control panel or from the control panel in the power house. Their control is arranged so that after the initial impulse is given to close the valve the valve will complete the operation even if all of the control wires between the power house and the valve panel are immediately severed and short circuited. The valve will close automatically if the penstock velocity exceeds 15 ft. per sec. Their casing is used as a Venturi section, and a mercury well mechanism operates a contact-closing device to secure this result. The valves are prevented from opening until the penstock is completely filled, after which a pressure-controlled switch makes contact, which permits completion of the opening circuit.

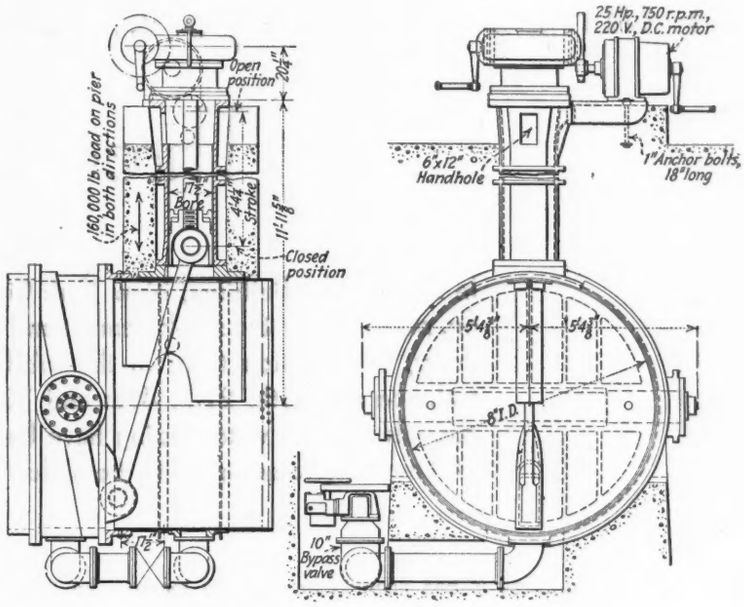
The penstock is filled by a 10-in. bypass around the main valve and is regulated by a motor-driven gate valve which is both locally and remotely controlled. This equipment is not provided with the non-stop closing feature and is under control of the operator at any point of travel.

Position indicators on each main and each bypass valve are provided by a voltmeter which registers the position of the arm of a variable rheostatic potentiometer.

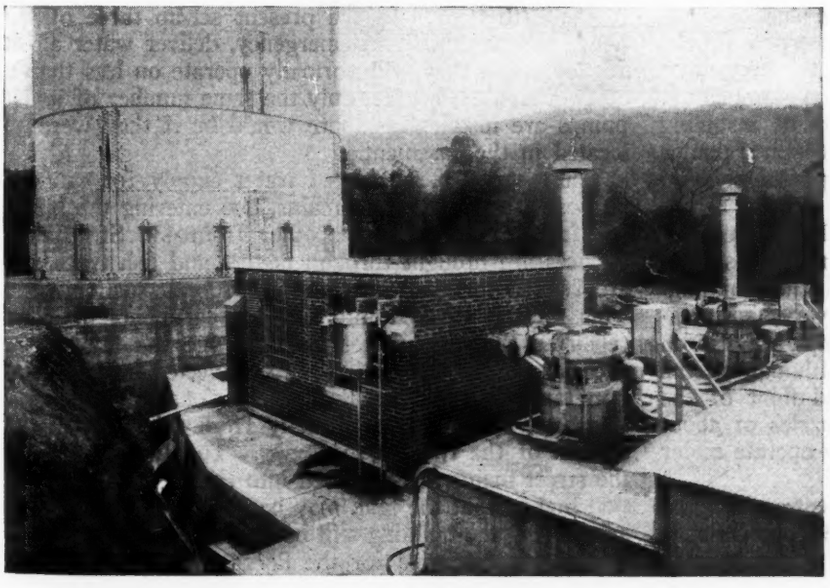
The valves are designed to offer minimum resistance to the flow of water, and the disk is shaped for the best streamline section. The arm and connecting rod shield are molded to create minimum hydraulic disturbance. One particularly important feature of the valve's design is the location of the pivot arm on the disk, permitting application of a thrust by the operating mechanism to overcome the water pressure and force the lower half of the disk firmly against the seat.

The water pressure exerted against the upper half of the disk insures proper seating of this portion of the disk. Leakage at the hub is controlled by metallic packing which may be adjusted or renewed with the valves in any position and under full head. All unfinished metal portions of the valve were given two shop coats of red lead, and after installation all exposed metal surfaces were given two coats of aluminum paint, which combination has proved by experience to provide a most durable protective coating.

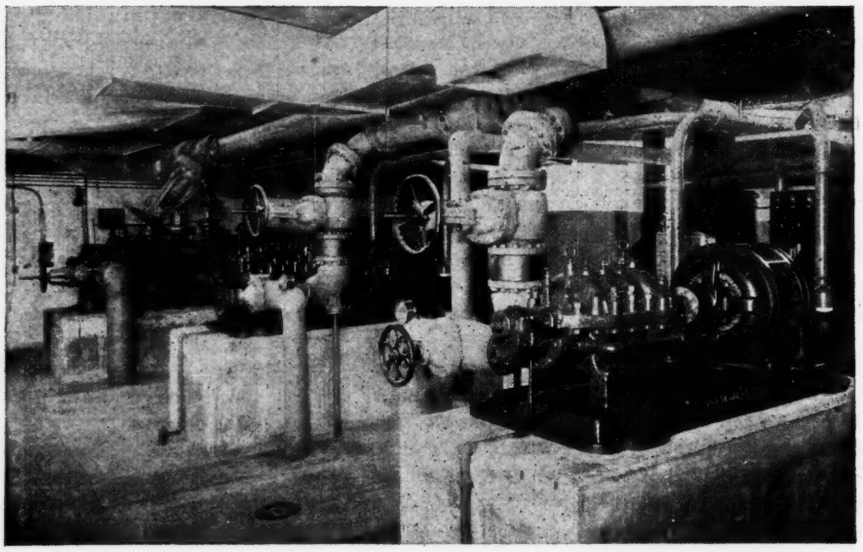
Cross-sections through one of the valves and its operating mechanism are shown below. The connection between the disk and the operating mechanism is indicated on the left. Although these valves and their bypass are arranged for remote-control motor operation, provisions are made for hand operation at the valves.



Above—Sections through one of the valves. The location of the pivot arm on the disk permits application of a thrust by the operating mechanism to overcome the water pressure and force the lower half of the disk firmly against the seat



Left—Base of the differential surge tank at the left, the brick valve-control house is in the center and the operating mechanisms for the two 96-in. disk-arm valves are at the right. The valves may be operated from the control house or from the power house



Two 400-g.p.m. house pumps and one 750-g.p.m. fire pump in the sub-basement driven by wound-rotor induction motors

By FRANCIS E. McARDLE
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Chrysler Building, New York City

Pumps in Chrysler Building Located on Three Levels

In the Chrysler Building, New York City, the house and the fire pumps are in the sub-basement and on the 25th and 48th floors, with suction tanks in the sub-basement and storage tanks on the 25th, 27th, 49th and 73d floors. The pump controls and the water piping have been arranged to insure 100 per cent water service to the building under all conditions

IN HIGH buildings it has been customary to locate the house and the fire pumps in the basement. On the same level with the pumps is a suction tank for the fire pump and another for the house pumps. On intermediate floors are storage tanks for the house and sanitary service, with a combination fire and storage tank on the top of the building. This system of installing water pumps and tanks in high buildings requires pumps for very high heads and subjects the piping system to these pressures at all times.

To meet the present New York City code requirements for a building as high as the Chrysler, fire pumps must be located on three levels up through the building. Because of this requirement and to avoid very high pressures in the piping system the house pumps are also on the same levels with the fire pumps. Although all the fire pumps can deliver water to the 73d floor of the building, under a pressure at the fire nozzles of about 60 lb. per square inch, they will normally operate under a medium head.

With all the house pumps in the basement a minimum of four would be required. Two of the house pumps, one for regular service and one a spare, would have to be capable of delivering water to the 73d floor tank; one would have to deliver water to the 49th floor and one to the 27th floor. In the present set-up three of the house pumps can, in an emergency, deliver water about 50 floors, but they will normally operate on less than a 30-floor lift. However, only the same number of house pumps are installed as there would be if they were all located in the basement.

There are two sources of water supply for sanitary purposes from the street mains, one entering the building from 42d St. and the other from 43d St. These services are brought through meters and fish traps and are twined together near the 10,000-gal. suction tank. This tank is divided into two compartments to allow repairing the float valves and cleaning the tank when necessary. The supply lines are connected into the suction tank through two float valves, one in each compartment. A line goes directly from this tank to the suction of the two house pumps. The two lines from the street mains are bypassed into the house pump suction line so that the tank may be disconnected from the system and the building still be supplied with water.

The water service for the floors from the basement

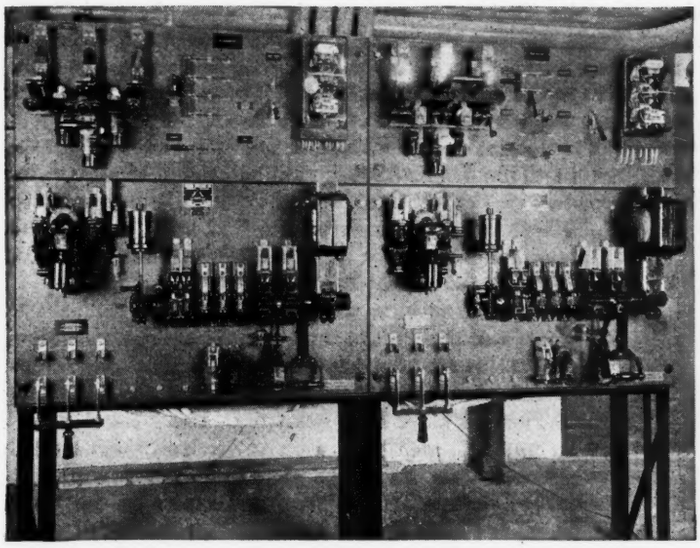


Fig. 1—Control panels for the two house pumps in the sub-basement

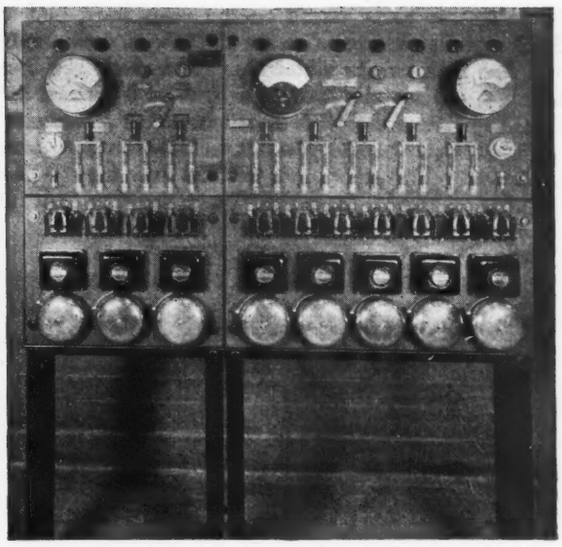


Fig. 2—High- and low-water alarm panels in the chief engineer's office

to the 3d is taken directly from the street pressure, which varies from 60 to 73 lb. The hot-water service for these floors is also supplied by street pressure, with the hot-water tanks in the sub-basement.

There is another water line brought into the building from the main in 43d St. that is used independently for fire service. This line connects through a float valve to a 10,000-gal. suction tank. From the tank a line goes to the suction of the fire pump. The fire pump suction may also be connected to the line from the street or to the suction line to the house pumps. A fourth line is brought into the building from the street mains to supply the sprinkler system installed on all floors up to and including the fourth.

On the intermediate floors in the building there are combined fire pump and house pump suction tanks, storage tanks and hot-water tanks. On the 73d floor there is a combined fire and house storage tank. The general arrangement of the system with the pumps and tanks is shown in Fig. 3.

It will be seen from the diagram that the building is so arranged that the floors are divided into three groups, each having its own water supply and fire service. The working pressure that this system is subjected to is less than 50 per cent of that on an installation where all pumps are in the basement.

The two 400-g.p.m. house pumps in the sub-basement discharge to a fire and house tank on the 27th floor. Either of these pumps is large enough to supply the building, the other being used as a spare.

From the fire pump, risers go to the fire lines on all the floors up to and including the 24th, and one line goes to the fire and house service tank on the 27th floor, with two connections to this tank. A connection is made near the bottom of the tank and normally is open to maintain pressure on the fire lines from the 24th floor down through the building. A connection, which is required by code, is made to the top of the tank through a valve, so that in an extreme emergency of the two house service pumps failing in the sub-basement, the fire pump can be used to supply water to the house and fire tank.

On the 27th floor are three tanks connected by a 6-in. equalizer line. One is the combination house service and fire tank, having 2,900 gal. capacity for the former and 5,000 gal. capacity for the latter service. The other two tanks have capacities of 4,200 and 3,200 gal., respectively, and are normally for house service. The total capacity of these three tanks is 15,300 gal., of which 5,000 gal. is for fire reserve.

The equalizing line between the three tanks is connected into the fire line by a valve so that in an emergency all the water in these tanks can be made available in the fire line below the 25th floor simply by opening one valve. From the 6-in. equalizer line a 5-in. connection is carried to a 3,000-gal. tank on the 25th floor, which serves as the house supply from the 23d to the 4th floors, inclusive. Hot-water service from the 23d to the 4th floors is taken from this tank, with the hot-water tank in the sub-basement.

From the 6-in. equalizing line on the 27th floor a 4-in. suction is taken to the 250-g.p.m. house pump on the 25th floor. A 6-in. pump discharge line is carried to the 15,000-gal. combined house and fire tank on the 49th floor. The pump's discharge from the sub-basement house pumps is connected by a bypass into the discharge of the 25th floor house pump. With this arrangement it is possible to connect either of the basement house pumps with the 49th floor tank. The speed of the basement house pumps can be increased so that they will develop sufficient head to discharge 200 g.p.m. into the 49th floor tank.

From the tank on the 49th floor a 5-in. line runs to a distributing main on the 47th floor to supply all floors from there down to the 24th, inclusive. The hot-water service for these floors is taken from the tank on the 49th floor, with the hot water-tank located on the 25th floor.

On the 25th floor the 750-gal. fire pump suction is connected to the bottom of the house and fire tank. By opening one valve the storage tanks can also be connected to the suction of the fire pump. Consequently all the water stored on the 27th floor may be made immediately available to the fire and house pumps for fire purposes above the 27th floor. The discharge of the fire pump runs to the fire and house service tank on the 49th floor. Two connections are made to this tank, one at the top and the other at the bottom. The top connection is normally closed with a valve, but the bottom connection is open to maintain pressure on the fire lines from the 47th to 25th floors, inclusive.

From the tank on the 49th floor a 5-in. suction line is

taken to the house pump on the 48th floor, and a 6-in. discharge line is carried to the 15,000-gal. combined house and fire tank on the 73d floor. The discharge from the house pump on the 25th floor can be bypassed into the discharge from the 48th floor pump. By increasing the speed of the 25th floor pump it will develop sufficient head to discharge 250 g.p.m. into the 73d floor tank. This tank supplies all service from the 71st to the 48th floor, including the kitchen of the Cloud Club, on the 67th floor. There are two hot-water tanks lines taken from the 73d floor tank. One is on the 60th floor and serves from the 60th to the 71st floor, inclusive. The other is on the 49th floor and serves the 48th to 59th floors, inclusive.

The suction on the 48th floor fire pump connects to the bottom of the fire and house tank and the discharge to the fire lines on the 46th to the 73d floors. It also connects to the bottom of the tank on the 73d floor, so that this tank maintains pressure on these lines at all times and provides a water supply for immediate fire service.

The bypass for pumping from the celler to the 49th floor and from the 25th to the 73d floors is for emergency only, in the event of a shutdown on any of the pumps. This arrangement can be used while repairs are being made. The discharge lines from all pumps were increased to 6 in. to cut down the friction and velocity noise which would occur while the pumps were running.

The fire pumps are on the same floors as the house pumps. They have a capacity of 750 g.p.m. at full speed. The fire pump in the sub-basement will pump to the 73d floor; during a test conducted at the building it discharged water from three $1\frac{1}{8}$-in. nozzles on the 73d floor with 60 lb. per square inch pressure at each nozzle. The fire pumps on the 25th and 48th floors can, when running at full speed, discharge water on the 73d floor at about the same pressure as the fire pump in the basement.

All pumps are driven by wound-rotor induction motors. Normally, the house pumps are under automatic control from float switches in the tanks which they serve. High- and low-water alarms on a panel in the chief engineer's office in the sub-basement connect to each tank and sound for high or low water. Indicators on this panel show the height of water in feet in all the storage tanks in the building. Should the water get low in a tank a red lamp corresponding to that tank will light and an alarm bell will sound. High water causes a green lamp to light.

On the engineer's alarm panel there are also signal lamps to show if the pumps motors' controls on the 25th and 48th floors are functioning properly. For each control there are two white lamps. One is connected to the float switch circuit and the other connects to the primary switch on the motor control. When the motor is energized the two white lamps light. If the float switch closed

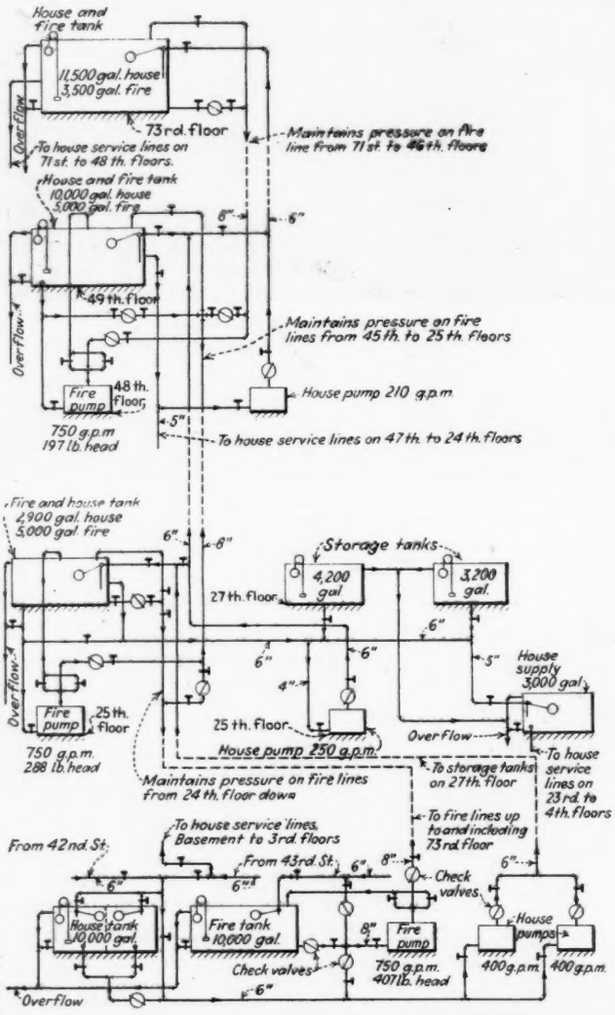


Fig. 3 (Above)—Diagram of the water storage tanks, the fire pumps' and the house pumps' connections

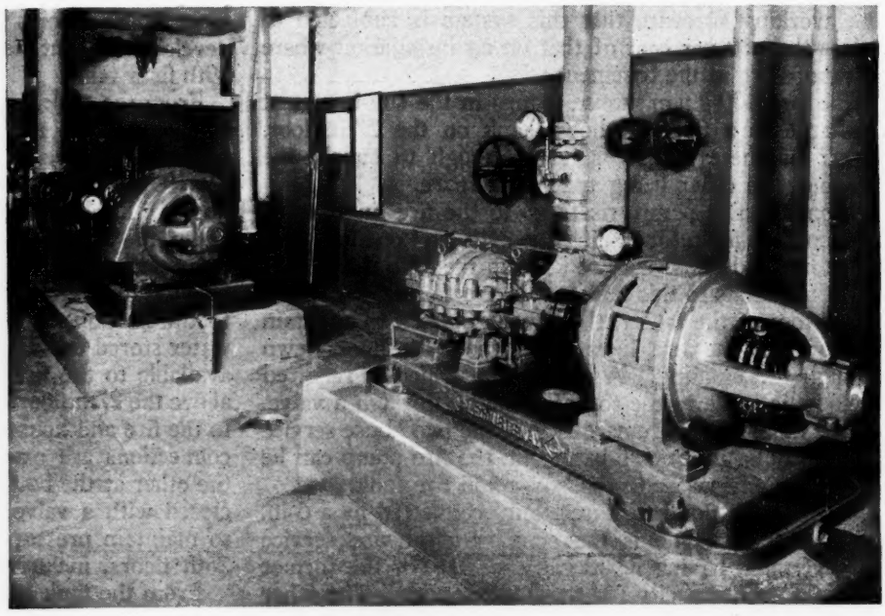


Fig. 4 (Right)—Pump room on the 48th floor. On the right is the 210-g.p.m. house pump and on the left the 750-g.p.m. fire pump, both driven by wound-rotor induction motors

to start the motor and the primary switch did not close, the float switch signal lamp would light, but the primary switch lamp would remain dark. This would show that there was some trouble on the control board, either the main circuit open or something else preventing the primary switch from closing. On the other hand, if the motor were running and the float switch opened to stop it and the primary switch did not open, the signal lamp on the float switch would go dark and the primary switch lamp would remain bright. This would indicate that although the tank was full the pump was still running.

Controls for the house pump are arranged so that they can meet any emergency. In the sub-basement there are two house pumps, both of the same capacity, and, as previously mentioned, normally delivering water to the 27th floor tanks. These pumps are driven by 60-hp., 190-volt wound-rotor motors that normally operate with a step of resistance in the rotor circuit to slow them down.

PUMP AND MOTOR CAPACITIES

Pumps	No.	Capacity G.p.m.	Head[1] Lb. per Sq. In.	Speed R.p.m.	Rated Motor Hp.	Control Type	Speed Control Steps
			190 to	1,050			
Basement, fire.....	1	750	422	1,750	300	Manual	12
Basement, house....	2	400	152	1,600	60	Auto. &	2
		200	252	1,750		Manual	
25th Floor, fire.....	1	750	137 to	1,140	200	Manual	9
			305	1,765			
25th Floor, house....	1	250	120	1,530	60	Auto. &	2
		250	235	1,750		Manual	
48th Floor, fire.....	1	750	115 to	1,300	150	Manual	5
			210	1,780			
48th Floor, house....	1	210	139	1,750	40	Auto. &	1
						Manual	

[1]The values of head and speed given for the fire pumps are those obtained by test.

If it is desired to pump to the 49th floor a three-pole switch is closed on the control panel that cuts out the last step of resistance; the motor then runs at its full speed of 1,750 r.p.m. and the pumps discharge at a head of 580 ft., sufficient to supply the tank on the 49th floor.

Each pump motor has its own control, and is arranged for both automatic and manual operation. On the 27th floor tanks there are two float switches, No. 1 and No. 2. Only one of these switches has control of starting and stopping any one pump at any time. A normal set-up is to have No. 1 switch start and stop No. 1 pump and No. 2 switch start and stop No. 2 pump. By throwing a four-pole, double-throw knife switch, No. 1 float switch can be given control of No. 2 motor and No. 2 float switch made to control No. 1 motor. Should the float switches fail, the automatic control can be made to function by closing a single-pole switch on the control board. With this arrangement the float-switch circuit is cut out and the pump must be started and stopped at the control board by closing and opening the single-pole knife switch.

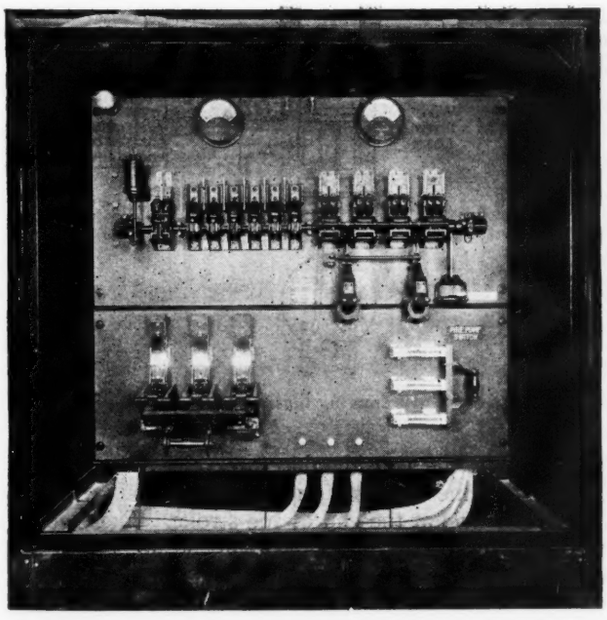
If the automatic control fails there is a manual control on each motor panel that will allow starting the motor by hand, but the motor can be stopped by the float switch.

The control arrangement provides a wide range of flexibility, and if a motor is in condition to run it can be put into service.

Normally, the house pump motor on the 25th floor is controlled by the float switch on the 49th floor tank. In case the pump fails, the 49th floor tank float switch can, by a suitable switching arrangement, be connected to the controls of the two pumps in the basement and either of these can be used to supply the 49th floor tank as previously explained. The motor on the 25th floor can be started and stopped with automatic control from a single-pole switch on the panel if the float switch fails to function. Should the automatic control fail, the motor may be started by a manual control, and if the float switch is functioning it may be used to shut the motor down automatically when the tank is full.

The house pump motor on the 48th floor can be started and stopped in the several ways explained for the other house pump motor controls. Normally it is controlled from the 73d floor tank. Should this motor or pump fail to function the house pump motor on the 48th floor can be put under control of the 73d floor tank float switch and operated to deliver water to this tank.

Manual control is used on all the fire pumps. In case of fire they are started on telephone instruction from the source of the trouble. The fire pump in the sub-basement as normally started will attain a speed to supply water to the 27th floor. There are then eleven points of speed control to give any desired pressure at the nozzles up to the full rating of the pump, which is about 60 lb. per square inch, or three $\frac{1}{8}$-in. nozzles on the 73d floor. The other fire pumps are also started and stopped manually and have speed control to give the desired pressure on the fire nozzles.



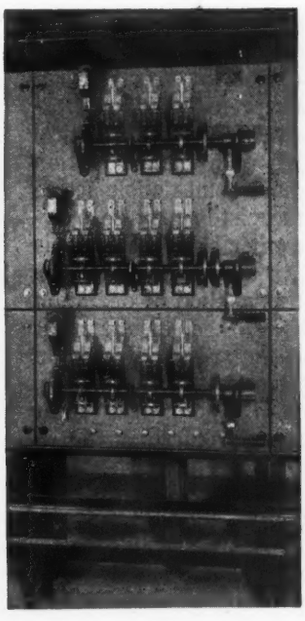


Fig. 5—The panel on the right is for manually starting the 750-g.p.m. fire pump in the sub-basement, and to bring it up to slow speed of 1,050 r.p.m., at which speed the pump develops 190 lb. per square inch pressure. On the right is the speed control panel for this pump. Eleven speed points are provided on this panel. At the highest speed, 1,750 r.p.m., the pump develops 422 lb. per square inch pressure

Advantages of Multiple-Effect Ammonia Compressors

By ROBERT S. WHEATON

The Vilter Manufacturing Company

THE multiple-effect design of compressor finds an excellent application in refrigerating plants where two widely varying temperatures are maintained and in ice-making plants where the water is forecooled at a higher temperature than that temperature at which the water is frozen.

One of the elementary facts pertaining to the economical operation of refrigerating equipment is that the higher the suction pressure the lower the power bill,

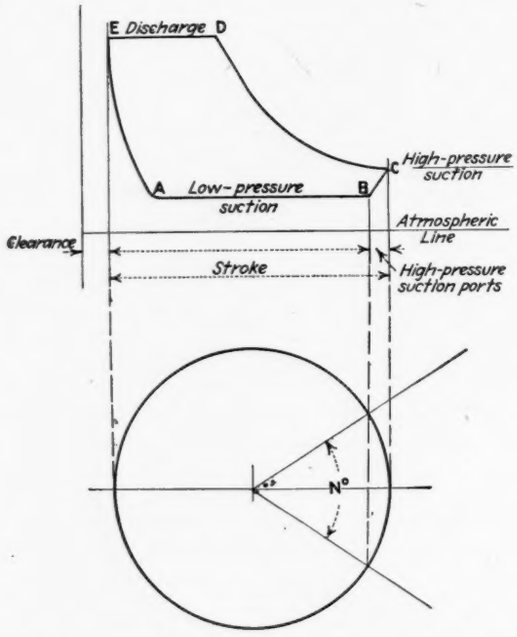


Fig. 1—Indicator diagram of a multiple-effect compressor

other things being equal. If it is not possible to run the entire load at a high suction pressure it may be possible to run part of the load at a high suction pressure.

This fact has long been recognized by refrigerating engineers, and it has been customary to build compressors with double suctions: In a two-cylinder vertical compressor, one cylinder operates at a higher suction pressure than the other; in the horizontal double-acting compressor design one side of the piston may be operated at a higher suction than the other side. While this answers the purpose fairly well, it was found that the unbalanced condition created by this method of operation requires more momentum in the flywheel or the rotor of the motor which operates the compressor, which, in turn, calls for a larger first cost and, in consequence, larger operating cost occasioned by the additional power required to turn this heavier revolving member of the compressor.

To overcome these faults the multiple-effect compressor was introduced and now is gaining considerable favor. The illustrations show the basic elements of the design of a vertical multiple-effect compressor wherein the conventional vertical inclosed type of compressor has been built with a series of ports placed at the end of the stroke of the piston. The number of cylinders utilized is usually two, although sleeve-valve compressors are built with as high as four cylinders. In the latter compressor the cylinder has a sleeve operated by eccentrics off of the crankshaft which uncovers a suction port at the top of the cylinder during one portion of the stroke and a second port at the central part of the cylinder at the end of the stroke. A characteristic of all these vertical multiple-effect compressors is the omission of the water jacket.

The work performed by the compressor is graphically shown in Fig. 2. Take the case of an ice-manufacturing plant: The high temperature side of the compressor is connected to the water forecooler, which may be operated at a suction pressure of 40 to 45 lb. The useful work performed by this side of the compressor is the cooling of the water. The ammonia is also cooled when the water is cooled in the forecooler, but that should not be regarded as useful work. There is also a wire-drawing loss, as well as a "port loss" occasioned by the fact that part of the stroke is not useful, because when the ports are uncovered the effective stroke of the compressor is decreased by the port opening.

After the ammonia has been cooled in the forecooler it is conducted to the ice-making tank, and the increase in capacity occasioned by this precooling of the ammonia must be taken into consideration. The useful work done on the low-temperature side of the compressor is, of course, the freezing of the water in the cans. On the low-temperature side of the compressor, there is the volumetric efficiency loss, also the port loss due to the decreasing of the length of the effective stroke when the center ports are uncovered.

It may be thought that the ports will be open for such a short interval that the gas cannot be properly introduced into the cylinder. That is not the case, because, due to the construction, the ports can be made of proper shape with a machine tool. By referring to the indicator diagram, Fig. 1, it will be seen that the ports remain

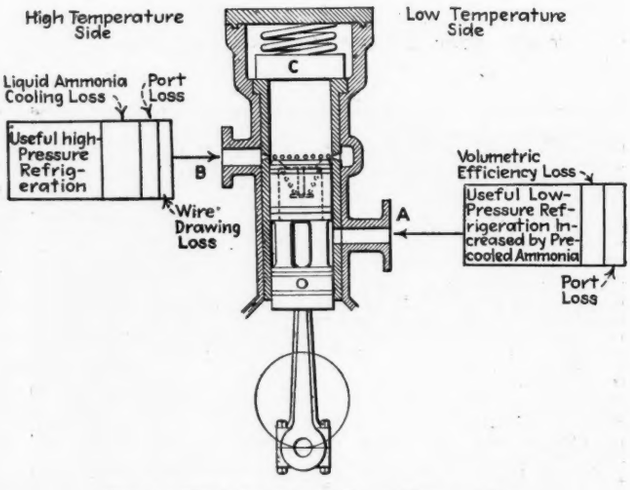


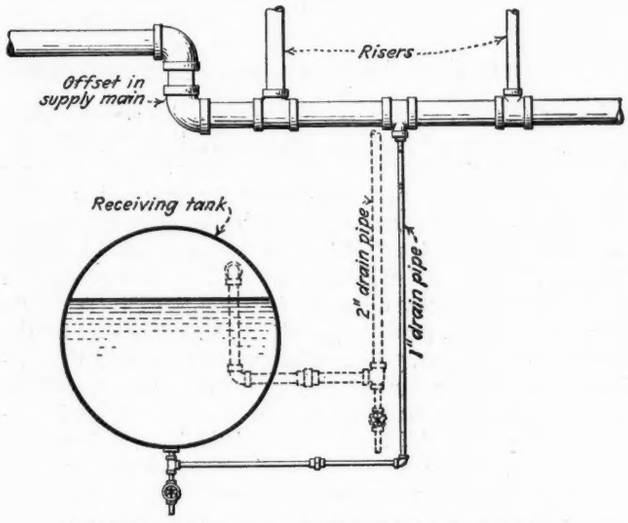
Fig. 2—Work done by high and low suctions

uncovered for the considerable interval of time during which the connecting rod pin travels through an arc of its total travel at the end of the stroke. These conditions are not theoretical, but actually occur. The diagram, although theoretical, closely approximates what actually obtains in practice.

...RIGHT OUT OF THE PLANT...

Altered Drainage Connection Removes Cause of Water-Hammer

OWING to the crowded condition of the power plant apparatus in the basement of a factory building, it was necessary to put a downward offset in the main supply line of the ordinary one-pipe heating system in use. Running up from the depressed section of the line were two risers which carried the steam to about half the total number of radiators in the building. This part of the system worked well for a time, but eventually a loud and persistent water-hammer would begin shortly after the steam would be turned on in the morning.



Original and improved drain connection to receiver

The cause of the commotion was a puzzle to the operator until one day a visiting engineer suggested that the 1-in. drain pipe, shown in full lines, might be stopped up at its point of connection with the receiving tank.

And so it was. All of the water for feeding the boilers was first delivered to the receiving tank. As the source of supply was impure, much sediment had accumulated in the bottom of the tank, choking the drain inlet and holding the condensation in the supply main and first-floor radiators—hence the water-hammer, also the necessity of carrying an excessive back-pressure on the engines, often as much as 10 lb., to force any steam at all through the pipes.

The defect was corrected by running a larger drain from the offset section of the main pipe and connecting it to the receiving tank above the water level, as shown by the dotted lines. Now there is no chance for the inlet to become plugged with mud and grease. With the altered arrangement, a back pressure of less than 1 lb. is sufficient to send the steam circulating whenever it is needed.

A. J. DIXON.

St. Louis, Mo.

Repairing a Riveted Seam by Welding

THE question in *Power* Jan. 13 dealing with welded joints is a timely one, for while some people of extensive experience and special method can make dependable fusion welds of a certain type, there is grave danger to life and property as well as to the success of fusion welding in the thought, which is gaining momentum, that anyone, by any method, can weld a perfect seam of any type.

Those who have demonstrated by laboratory tests and by thousands of vessel-years of successful service that a fusion-welded seam may compare most favorably with a well-designed riveted seam have been able to do so only as the result of careful attention to each stage of construction and to the design and preparation of the plate ends for welding. The most accurate assembly of the parts, which in many cases have been hot-formed, is carried out, and there is close supervision of the actual work of welding, which is done by a process developed after many years of experimenting. None of these steps can be applied to the repair of a riveted seam that has developed leakage in service.

The horizontal return-tubular boiler has afforded a wonderful opportunity for the self-styled expert welder to show his ability to repair the fire-cracked girth seam. In many cases the tubes and through rods were carrying almost the entire load, so the safety of the boiler depended upon the success of the weld to but a slight extent; yet the failures outnumber the welds that did not give trouble within a year. One boiler repaired by welding the calking edge to prevent leakage cracked at the weld when the boiler was out of service and not under pressure.

A seam, repair of which was attempted by welding, had a crack extending from rivet hole to rivet hole for a distance of 60 in. That crack had been the cause of the inability to keep the seam tight by calking and was not discovered until after the third unsuccessful attempt at welding, when rivets were removed and the walls of the holes examined.

Before deciding upon repairs of any description the cause of the trouble should be determined. A properly designed and riveted seam in a sound boiler plate not exposed to the products of combustion does not leak under 450 lb. steam pressure, regardless of the rate of evaporation.

If the boiler is new or has been operated under favorable feed-water conditions it is not likely, although it is possible, that a seam crack exists, and the trouble may be

due to poorly driven rivets or improper curvature of the butt straps.

Seal-welding of firebox seams, girth seams, rivet heads and tube ends has been practiced by several boiler manufacturers and railroad repair shops with more or less success. But no seal-welding should be done until the part has been subjected to a hydrostatic test and made tight by the usual methods of mechanical calking.

Of course, the mechanical calking is destroyed in the welding process, but the riveted seam which experiences the slight slip and remains tight under the 150 per cent hydrostatic test possesses a certain degree of good workmanship which may not be found in a riveted seam that has been made tight by fusion welding.

It requires no special gift of vision to look forward to the general use of high-pressure boilers having fusion-welded seams, but the specifications covering the construction will be so rigid that the process will be limited in its application and cannot be adapted to the general run of repair work.

For years to come boiler repairs will be made by the methods in use today, and this should include the tightening of a riveted seam by calking unless the conditions surrounding the leakage are unusual and a thorough investigation proves conclusively that the cause of the leakage, as well as repairs made by welding, has no influence upon the safety of the boiler.

New York City. M. P. JARED.

Stoker Setting for Scotch Marine Boiler

I SHOULD like to ask a few questions in regard to the article entitled "Stoker Setting for Scotch Marine Boiler," which appeared in the Jan. 13 number.

Chicago having adopted the code of the A.S.M.E. and also coming under the regulations of the National Board of Boiler and Pressure Vessel Inspectors, I am wondering if it can accept the water arch as described.

The author states that it is all-welded, and I assume he refers to oxyacetylene welding. How, then, does the water arch meet with the requirement of the boiler code? Can 3-in. standard wrought-iron pipe be used if it is to be exposed to the products of combustion? Are the tubes (that is, the 3-in. pipe just mentioned) properly rolled and flared in the headers before being welded? Where do the makers get any authority for welding the joints of the piping? The code does not seem to cover the case. What provision has been made for cleaning out the lower 6-in. steel pipe? It seems imperative that a clean-out would be necessary at this point, as it appears to be the lowest part of the boiler. Am I to infer that the water pipes are used as oven supports or is there some other means of supporting them? The layout shows the water pipes forming the support, and this would, it seems to me, throw a great strain upon the piping.

I should be glad to see other readers give their opinion as to whether this method of construction conforms to the boiler code. Also would like to know if the city of Chicago inspectors approved the installation, or has it been accepted by insurance inspectors? I should also be glad if the author would advance the information designated by the foregoing questions, for if the construction meets with the approval of the A.S.M.E. and National Board, I should like to know on what sections of the code he bases his arguments.

Binghamton, N. Y. CHARLES W. CARTER, JR.

Carbon Monoxide in Diesel Engine Crankcases

IN THE Jan. 6 number W. S. Brown takes exception to the statement that carbon monoxide gas will be found in the crankcases of diesel engines.

In one of the plants operated by the company with which I am connected an operator was overcome by this gas, causing the management to issue a bulletin on its dangers.

In Morrison's "Diesel Engines" the author says that in diesel engine tests the exhaust shows 0.2 per cent CO. The carbon monoxide gas found in the crankcase probably comes from the blow-by past the piston rings. And it is possible that some of this gas escapes from the combustion chamber before it has a chance for complete combustion. The chances of CO in the crankcase of diesel engines today is small compared to former years, as the operators and owner of diesels are more alive to the extra costs of running an engine until it refuses to operate any longer. WILLIAM W. DINGWALL.

Walthill, Neb.

Preventing Penstock Valves From Freezing

SOME TIME ago it was found that the water within the operating cylinders and control piping of two penstock gate valves had frozen. These valves were located in a room forming part of the generating plant. No provision had been made for heating, as the climate was not consdered so cold as to warrant the additional expense. Freezing was due to neglect to replace the covers that had been removed from the roof to facilitate inspection of the packing glands at the upper end of the operating cylinders. The valves were open and the cylinders were full of water to support the pistons. While frozen the valves were, of course, inoperative, and serious damage would have resulted had an emergency arisen that would have required stopping the flow of water to the nozzle bodies. The effective head at the valves was about 1,000 feet.

When the conditions became known immediate steps were taken to thaw the cylinders. In this case the most effective method was to heat the valve room by means of open wood fires laid on mats of earth to protect the cement floor. Sufficient hatch covers were removed to carry away the smoke, and a good-sized fire was soon under way near each valve in the room. Discarded form lumber served as fuel. Certain hatch covers were partly or entirely closed, as the condition of the fires permitted, it being desired to heat the valve room as quickly as possible without unnecessarily blackening the painted walls. The room was effectively heated, and after a few hours the valves were free of ice and were found to operate satisfactorily. Fortunately no damage was done to the walls or floor.

In order to be certain that, even with the hatches tightly closed, these important valves would never again be inoperative because of freezing, ducts were installed so that warm air from the generator room could be forced into the valve room by motor-driven blowers. In addition electric heaters were installed for use when the temperature of the generator room became too low, as might be the case when light loads would be carried for extended periods. Pending installation of the heat-

ing equipment, two thermometers in the valve room were read hourly to be certain that its temperature remained above 45 deg. F. Fuel was kept in readiness for lighting, but since the hatches were tightly closed fires were unnecessary.

Several years ago, in another plant, in a very cold climate, water in the nozzle body and a short section of penstock connected thereto would freeze during cold weather if the needle nozzle remained closed very long. This was a 1,500-kva. unit, and freezing occurred in a pit beneath the generator room floor. This trouble was overcome by installing a large wood-burning stove in the generator room, and connecting the flue to the nozzle pit. Sufficient draft was maintained by the water wheels, two or more of which were always in operation, to insure good combustion. Heating was regulated by a damper in the flue. While this method was rather crude, it effectively served its purpose for a long period.

Irvington, Calif. K. L. JOHNSON.

Emergency Repairs to Pump Piston Rod

THE ARTICLE on page 115 of the Jan. 20 number entitled "Emergency Repairs to a Pump Piston Rod" is interesting and recalls similar troubles I encountered when aboard ship. However, I feel that I handled them perhaps a bit more mechanically. At any rate I should like to warn against the drastic method of drilling into piston rods for the purpose of anchoring babbitt. It weakens the rod, and unless the holes are at varying angles or are of a dove-tail shape they do not hold the babbitt securely. And any pump that is subject to severe duty, such as handling gritty water, must, to be even temporarily repaired, have the fill metal well amalgamated to the rod.

Where I have had badly scored water pump rods handling salt water I removed the rod and thoroughly cleaned it with acid and scraper to a bright surface. Then I used a heavy soldering copper and thoroughly tinned the surface. Then with a torch and a quantity of best-grade solder I built up layers of solder at the most scored sections, finally having the rod turned to size. Many scored cylinders of reciprocating engines have been treated the same way.

Concord, N. H. CHARLES H. WILLEY.

Pouring Baffles With Plastic Material

THE ARTICLE in the Jan. 27 number, by W. F. Shutt, on "Pouring Baffles With Plastic Material," was of much interest to me, as I have been in the boiler baffle business exclusively for the past twelve years.

I have experimented many times with machines for placing plastics, and so far have been unsuccessful in finding one that would answer the purpose satisfactorily. Placing the material by hand, to me, is the only practical way, for then the plastic is placed and tamped as it should be.

In the method described by Mr. Shutt, I cannot see how it would be possible to keep the baffle with an even thickness. Any baffle over 4 in. in thickness is not necessary, and any under 4 in. in thickness is too frail to withstand the knocks of boiler operation in general. I have not yet found a diagonal alley in a horizontal water-tube boiler over 2 in. in width.

Mr. Shutt says he used a $2\frac{1}{2}$ in. hose to place the plastic. As the hose would have to be flattened to a certain extent to allow it to be placed in the tube alley, I cannot see how the hose is withdrawn to fill the next pocket.

The plastic is forced from the hose with 100 lb. air pressure, and this, of course, would have a tendency to return the hose to its normal shape. In so doing, it would wedge itself in the tube alley. How can the hose be moved without first emptying it? As the cylinder holds over 125 lb. of plastic and a pocket of baffle holds not over 10 lb., there is a good deal of plastic left in the hose and container. So far as I can see, most of this must leave the hose before it can be moved. As the pocket is already filled, what is done with this excess plastic?

In my opinion, it is impossible to build a plastic baffle without voids unless it is tamped in place by hand, as the weight of the plastic before setting will settle away from the bottom of each tube. Unless these voids are corrected before the wall has set, they will, in turn, deteriorate and tear down the baffle, as the gases going through them will tend to wear the wall away.

It has been my experience that a baffle wall must have some type of separator to take care of the expansion and contraction of the boiler, otherwise the strain set up in the wall will tend to crack it and allow it to fall down.

Newark, N. J. J. W. PUTNAM, JR.

Flash Barriers for Rotary Converters

WE HAVE two 1,000-kw. 6-phase rotary converters in our plant used for street railway service.

Considerable trouble has been experienced from flashovers; often causing brush "pig tails" to be burned off and occasionally flashing on the alternating-current rings.

These machines are of an obsolete slow-speed design, but as they are still giving good service it was decided to equip them with "flash barriers."

The manufacturer quoted on a set of barriers to be made of asbestos board, but the cost was higher than we anticipated; so it was decided to try out a set of home-made barriers using $\frac{5}{16}$-in. red fiber instead of asbestos.

The outside ends of the brush rocker arms were already tied together with strips of fiber $\frac{1}{2}$ in. thick, so we only had to mount duplicate pieces at the opposite end on the armature side.

These end pieces serve as supports for the barriers, each of which was made to fit closely between them and fastened with one small sheet-metal angle clip at each end, the idea being to keep at a minimum the metal in the flash zone. We used $\frac{3}{16}$-in. machine bolts throughout with a lockwasher on each one.

The second machine was also equipped, showing a saving over the factory bid of nearly $200. We find that these fiber barriers are better than asbestos in that they do not collect a metallic film from flashovers.

The completed job made a very presentable appearance. The barriers have been in service over two years and neither machine has had more than four flashovers in that time, none of them severe. We used to expect about one a week; so the barriers have certainly been worth installing. THOS. E. MILLER

Nashville, Tenn.

From Among Readers' Problems

Conducted by
L. H. MORRISON

SULPHUR IN FUEL OIL—*We are interested in obtaining a specification covering the allowable maximum percentage of sulphur to be contained in fuel oils for diesel engine operation. So far as we have investigated, we have been unable to find any definite recommendation or requirements as to permissible sulphur content.* R.P.A.

The permissible amount of sulphur depends upon the limitations the user or engine manufacturer sets as to allowable corrosion of the exhaust connections. Seldom does sulphur attack the cylinder and other engine parts, and if the crankcase is vented by being connected to the air intake, blow-by of sulphur fumes will not impair the shaft or bearings.

A sulphur content of as high as 2 per cent is not objectionable if the engine, prior to being stopped, is run on a light sulphur-free oil to clear out the exhaust line, which otherwise might corrode from the condensation of the sulphurous acid gas.

GRINDING DIESEL VALVES—*Upon overhauling our diesel engine we find that the valve seat reamer we have will not touch the valve-cage seat, which seems to be as hard as tool steel. What is one to do?* T.D.A.

If you have a small electrically driven grinder, the best process is to mount the cage on a lathe and take a light cut over the seat. This will remove the flint-like skin, and the job may be finished with the usual hand grinding of the valve to its seat with a compound. In the absence of such a grinder, use a file to cut away the hardened surface.

MEANING OF THE TERM "MOL"—*I have seen the term mol used in literature on gases, but nowhere have I seen an explanation of what it means.* C.D.

The mol is that volume of a gas which has a mass in pounds equal to the molecular weight of the gas. For example, the molecular weight of hydrogen is 2, so a mol of hydrogen is a volume weighing two pounds. As the number of molecules of any gas contained in a cubic foot is the same, it follows that a mol of any gas occupies the same volume. At the standard pressure of 14.7 lb. and temperature of 32 deg. F. a mol has a volume of 357.7 cubic feet.

The use of the mol simplifies many processes. For example, the combustion of carbon and oxygen forms carbon dioxide. It may be written as $C + O_2 = CO_2$, or we may set down the molecular weight and write it

$$C + O_2 = CO_2, \text{ or}$$
$$12 \text{ lb.} + 32 \text{ lb.} = 44 \text{ lb., or}$$
$$1 \text{ mol} + 1 \text{ mol} = 1 \text{ mol}$$
$$357.7 \text{ cu.ft.} + 357.7 \text{ cu.ft.} = 357.7 \text{ cu.ft.}$$

Ordinarily, of course, carbon does not exist as a gas, so a better illustration would be the combustion of methane, CH_4. The combustion may be written in symbols as

$$CH_4 + 2O_2 = CO_2 + 2H_2O$$
$$16 + 64 = 44 + 36$$
$$1 \text{ mol} + 2 \text{ mol} = 1 \text{ mol} + 2 \text{ mol}$$
$$357.7 \text{ cu.ft.} + 715.4 \text{ cu.ft.} = 357.7 \text{ cu.ft.} + 715.4 \text{ cu.ft.}$$

The volumes are based on 32 deg. temperature. The volume at the actual temperature may be found by using the ratio of the absolute temperature, which, if T is the actual temperature in deg. F, becomes $\frac{T + 460}{32 + 460}$

PREVIOUS QUESTION
DISCUSSED BY READERS

THE QUESTION

IN OUR 300-bed hospital the water from the city mains is reduced to zero hardness for all parts of the institution.

Upon opening the hot water heaters after 15 months' use we found the shell badly pitted, which will mean new heaters at the end of three years. How can this be overcome? E.L.E.

IF A hard raw water is used in a hot-water system scale will be formed on the walls of the piping and tanks. If by a softening process this water is reduced to zero hardness the tendency to form scale will be eliminated, leaving the bare walls of the piping and heaters exposed to the action caused by any oxygen, which may be present in a form such that it can combine with and oxidize the iron walls of the containing vessels. This oxygen usually comes through in gaseous compounds entrained in the water.

The condition may be relieved by giving the heaters a protective coating of scale, or it can be relieved or even eliminated by removing the cause of the corrosion.

A protective coating may be applied by either allowing the softened waters to come through with a slight hardness, or it may be applied by periodically bypassing the softener and allowing raw water to flow through the system for a period of time.

Where the installation is large, the replacement costs high and parts are deteriorating rapidly, as is indicated by the question, it might be more economical to install a deactivating or a deaërating system. Either of these would eliminate the entrained gases, which are the cause of the corrosion, and would permit the hardness to be held at zero. EDWARD B. CARY.

Cleveland, Ohio.

IT IS possible that this rapid corrosion was caused by the water, especially if the water is from a moorland district and contains a small per cent of humic acid, which readily attacks all metals and metal-plated linings. If the water is dark in appearance, organic matter in suspension is undoubtedly pitting the shell.

The character of this zero hard water will govern the metal used for pipe and heaters. Iron, steel and brass, popular metals used for shells, cannot be used successfully with this water for any length of time, except when provided with a protective lining. Copper, without any soldered joints, is ideal but expensive and not entirely immune from the destructive action of all waters. Iron tanks lined with copper give good results, as do iron tanks lined with tar-paint preparations. Protective linings using arsenic and cyanidic ingredients in their preparation should not be permitted on account of the possibility of the water, when heated, carrying off some of the poison in solution.

The tar paint should be mixed to a heavy consistency and applied with a brush and well brushed out. Several coats must be applied before the shell

is in condition for use; each coat should dry thoroughly before the next is applied, and the shell, after being finished, should dry for several days before it is put into service. This method has been used in many instances.

WILLIAM ANDERSON.

Brooklyn, N. Y.

—◆—

WE HAD a similar condition to contend with in our plant. After installing a water softener in our 400-bed hospital, not only did the hot-water tanks start to pit, but the laundry engineer refused to use the hot water because the oxide content of the water discolored the wash.

Having been a marine engineer and having faced the corrosion problem more than once, I knew that the simplest remedy for corrosion on iron surfaces was to paint the clean iron surfaces with a mixture of good Portland cement and water mixed to a consistency of whitewash.

We opened up the heaters by taking off the manhole doors, put a man inside with a chipping hammer, scraper and wire brush, with instructions to clean off all corrosion and dirt. Then he was given the mixture of Portland cement to paint over the surface, using a whitewash brush and giving a second coat when the first dried.

This treatment was carried out a year ago, and so far I have had no complaint from the laundry engineer about rusty water. Recently when I opened up the heater the coat of cement was still intact. A. I. ROE.

Orange, N. J.

—◆—

EXPERIENCE with boilers and heaters has brought out the fact that pitting takes place on surfaces under the water line, while the surfaces that are subject to the scouring action of steam will not show pitting.

The cause of pitting may be any one or more of three: (1) action of dissolved acids in the water; (2) electrolytic action; or (3) action of dissolved gases, O_2 and CO_2.

A simple test with phenolphthalein indicator and titration with caustic solution will reveal the presence of acid. Chemical treatment, preferably with caustic or soda ash to neutralize the acid, will remove this cause.

Cases of corrosion due to electrolysis are rare, but galvanometer readings taken at different points will show if electrolysis is taking place. Proper grounding is the only corrective.

Pitting will take place due to the presence of the gases, oxygen or carbon dioxide. Heating the water in open or deaërating-type heaters to a temperature equal to the boiling point of water will remove these gases. If this cannot be done, the pitting action can be greatly reduced by applying a protective coat of paint to the surfaces. These must be clean so that the paint will from a continuous blanket to protect the inner surface.

Canton, N. C. HAROLD HANSEN.

A Question for Our Readers

WHEN junior size underfeed mechanical stokers are installed under the grates of downdraft boilers the comparatively cold, water-filled grates are immersed in the hot zone of the fire, and complete combustion may not be secured.

The question arises, how far below water grates should the retort bowl of an underfeed stoker be placed for most efficient and smokeless combustion of high-volatile fuels. In other words, what value, if any, has the space above the water grates for completing the combustion of volatile gases.

Has any reader made a CO_2 exploration of the combustion space of a down draft furnace with variable distances between retort and tubes in order to determine the most economical setting?

For an economical, or any other reason, should such water grates be removed entirely? F.E.R.

Suitable answers from readers will be paid for[1] and published in the April 7 number

ZERO hardness soft water may be proper for the elimination of scale, but unless provision is made to vent all entrained and liberated air to the atmosphere, marked pitting will inevitably ensue. Deaëration of the water supply will ameliorate this trouble.

In lieu of proper precautions, frequent coating of the inside surface of the shell with corrosion deterrents, such as bitumastic paints, will help.

It would be well at the time of renewals of the heaters to investigate the merits of non-corrosive lined units. Of course, none of these, even with shells made of solid copper, is entirely free of pitting unless properly vented.

F. C. NEILSON.

West Hartford, Conn.

[1]Instead of cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.)

Morrison's *American Diesel Engines*; Walker and Crocker's *Piping Handbook*; Norris and Therkeisen's *Heat Power*; Emswiler's *Thermodynamics*; Church's *Steam Turbines*; Uehling's *Heat Loss Analysis*; Croft's *Steam Power Plant Auxiliaries and Accessories*; Powell's *Boiler Feed Water Purification*; Osborne's *Power Plant Lubrication*; Moyer and Fritz' *Refrigeration*; *Rietschel - Brabbee's Heating and Ventilation*; Annett's *Electric Elevators*.

MY ANSWER is, reverse the polarity of the heater and maintain it cathode instead of anode as at present. When this is done, corrosion and scale formation cannot take place. Corrosion is an anode action, and heaters being anodic to the ground are therefore subject to corrosion, which is intensified by acid radicals and oxygen. Bear in mind that it is quite possible to have corrosion where oxygen is not present.

The method of reversing the polarity of the heater is as follows: Mild-steel anode bars are installed and immersed in the water (which is now the electrolyte) of the heater, and are insulated from the heater. A direct low-tension current is supplied to the anode bars from the outside through a master electrode, and these bars become the anode pole and are sent into solution and sacrificed to protect the surfaces of the heater. The current passes from the anode bars, breaking up the molecules of salts and holding them distinctly apart and in suspension in the water. The salts cannot combine again to form scale. The heater surfaces are now maintained cathode, and the cathode potential, being raised to the desired extent, prevents the metal from going into solution. No matter how badly pitted and corroded the heater may be before the above is done, it will not corrode or pit any further as long as the current is maintained on the anode bars.

Should there be any objection to the discoloration of the water due to the anode bars going into solution, graphite bars may be used. The graphite bars will last for many years, but the steel bars will have to be partly renewed in three years.

The heaters at the Delaware Station of the Philadelphia Electric Company have been protected by the Kirkaldy system for four years. They were so badly pitted and corroded before the installation of that system that they were about to be scrapped.

Checking up on the amount of money that it takes to protect a 10,000-sq.ft. boiler with the method outlined, I find that it can be accomplished for ten cents per day. ERIC G. HAHN.

Brooklyn, N. Y.

—◆—

IF THE hospital has two or more hot-water heaters, the best procedure is to cut out one and give it two coats of well-prepared red lead and linseed oil. If there is only one heater in the place, I believe that a galvanized-iron primer paint the best, as this paint dries quickly. The tank can be shut down at 6 p.m., wire-brushed and painted and put back on line at 6 a.m. This will have to be done once a month.

I have also made a separate hard-water connection into our heater, and we open this at night when our laundry is off, and run the soft water 2 or 3 deg. hardness. This will counteract pitting to a large extent.

CHRIS SIMONSON.

Prince Albert, Sask.

THE ENGINEER'S

Comprehensive Diesel Data

AMERICAN DIESEL ENGINES. *By L. H. Morrison, associate editor of* Power. *Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York City; 1931. Cloth, 6x9 in.; 606 pages, illustrated. Price, $5.*

Reviewed by

M. J. REED

Research Engineer, Diesel Engine Manufacturers' Association

NOT MANY technical writers can approach their subjects from the various angles of designer, erector, operator, and editor. Twenty years of experience in the diesel-engine industry has made this combined approach possible, however, to L. H. Morrison in the preparation of "American Diesel Engines." More, therefore, is expected of Mr. Morrison on this subject than of any writer with less background. He does not disappoint us.

It is the editor who writes the chapters on the history of the industry and on the economics of diesel power. In the former a good balance is maintained between the bare, essential facts and tiresome details. The chapter on economics covers well-worn ground but in a way quite competently comprehensive—consolidating such diverse applications as central stations, ice plants, cotton gins, flour mills, locomotives, etc.

In two chapters, entitled "Modern Air-Injection Diesels" and "The Airless-Injection Diesel," the author shows the essential features of the various subdivisions of these two main groups and goes on to catalog the various makes. The high spots of design are outlined for some two-score of current engines as well as for some obsolete designs.

The details of engine parts are well covered in chapters on frames, main bearings, pistons and piston pins, connecting rods, cylinders and cylinder heads, admission and exhaust valves, fuel valves of air-injection diesels, fuel pumps for air-injection diesels, mechanical-injection fuel valves and pumps, and air-injection compressors. Some idea of the thoroughnesss with which various designs are discussed can be had from the fact that these chapters alone take up 281 pages and contain 228 diagrams and photographs.

Separate chapters bear upon lubrication and fuel oil—the latter including a very novel chart showing the variation in standard properties of fuel oils from the more common crude oils. Some authorities will disagree with the author on the importance of viscosity and therefore wish that more space had been devoted to the effect of this property with various types of engines. However, these small exceptions do not seriously detract from the general completeness of the fuel-oil information set forth.

One wishes that more space had been alloted to supercharging—especially in its commercial aspects—in the chapter on engine output. The Hawkes' tests on supercharging might have furnished a more complete body of data than the test set forth in the text.

From his operating experience the author sets down in two chapters well condensed instructions for installation and operation. The brevity of these is no guide to the amount of operating information in the book, however, since much on this score is inserted under other subjects.

In conclusion it may be said that the author has compiled a work of almost encyclopedic character, which can at the same time be read with sustained interest. Specialists will find it a handy index to information not included within the boundaries of their provinces. Those without previous acquaintance with the diesel engine will find it a comprehensive guide.

Electricity Simplified

ELEMENTARY ELECTRICITY. *By Edgar P. Slack, assistant professor of physics, Polytechnic Institute of Brooklyn. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York City; 1931. Cloth, 5½x8 in.; 278 pages, 221 illustrations. Price $2.*

TO THE AVERAGE practical electrician, coming to a vocational school for training in the elementary principles of electricity, an algebraic formula is something worse than a hardship. He may be willing to read and accept that the current flowing in a circuit is equal to the voltage divided by the resistance, but $I = E/R$ to him is somewhat of a nightmare. In this book there are no nightmares, since there are no algebraic formulas. Where it is generally considered necessary to use formulas the author has written it all out in simple English.

The work is divided into ten chapters; namely, direct-current circuits; current; resistance; voltage; direct-current generators; direct-current motors; energy and power in direct-current circuits; alternating current; distribution systems and polyphase apparatus; vacuum tubes and radio reception. The book is essentially a text for vocational schools, but anyone wishing to gain a knowledge of the fundamental principles of direct- and alternating-current circuits and equipment by home study should find this book well suited to their needs.

Psychology in Industry

PREVENTIVE MANAGEMENT: MENTAL HYGIENE IN INDUSTRY. *A symposium edited by Henry P. Elkind. Published by the B. C. Forbes Publishing Company, 120 Fifth Ave., New York City; 1931. Cloth, 5x8 in.; 234 pages. Price, $3.*

ALL TOO OFTEN, the ounces of prevention outlined to prevent pounds of cure for labor troubles achieve this figurative weight advantage simply because they are more vaporous. The usual generalizations to the effect that added employee · welfare efforts mean added net profits would certainly fall particularly flat at this time. But the evidence assembled by the eight contributors to this work, all recognized figures in personnel work, cannot be dismissed as another academic effort to give a corporation the aspects of a country club or a charity hospital.

A fortunate conbination of industrial, medical, and academic points of view makes the symposium an ideal starting point for executives who may be wondering just how far efficent management ought to go in applying the X-rays of mental hygiene to the intricate mechanism of human personality.

Now this volume provides no magic formula for eliminating the friction that every individual, and every group, generate in the contact of their self-interest with their environment. It does serve to indicate how disasterous this friction, though often invisible, may be to the individual in its wear and tear on human emotions, and to the corporate structure in its effect on production efficiency. And it indicates where one may turn to find the imperfect lubricants so far developed to reduce this friction.

To the executive familiar with progressive personnel policies, most of the facts quoted may be familiar. The interpretations which have been woven around them, however, make it valuable to the initiated as well as to those who are still startled to learn, for example, that noisy surroundings may mean a 19 per cent difference in energy expenditure. It is difficult to see how a reader concerned with personnel problems, on finishing this book, could fail to turn to the bibliography it contains resolved to go deeper into the analysis and control, if that be possible, of the emotional stability of his workers. At least, he could have little doubt that the workers' fears and irritations and delights are just as basic factors in production efficiency as his manual dexterity or intellectual training.

Reviewed by E. SCOTT PATTISON.

BOOKSHELF

Heat Transfer in Boilers

ARITHMETIC INVESTIGATIONS OF HEAT TRANSPOSITIONS IN THE LOCOMOTIVE BOILER BARREL. *By Dr. U. Barske. Published by Hanomag-Nachrichten-Verlag, Postfach 55, Hannover-Linden, Germany; 1930. Paper, 6x8½ in.; 81 pages, diagrams and tables. Price, RM3.*

IN THE FIRST PART of this work, published in German, exact mathematical equations are derived for the determination of the variation of temperature in boiler tubes, flue and superheater tubes. These equations follow the latest findings in heat-transfer research, and the method of mathematical treatment is entirely new for the various superheater tvpes.

The second part shows examples for the practical use of the equations obtained, the application of which is essentially facilitated by the addition of diagrams and tables. The usefulness of the indicated method of calculation is proved in conclusion by a comparison of the calculated and test results.

Beyond the scope of locomotive construction proper, this work should be of interest to every heat engineer in whose designing practice a case of heat transposition similar to that of the locomotive boiler barrel occurs. The method of derivation may always be applied advantageously to make possible the mathematical treatment of such cases.

International Economics

THE WORLD'S ECONOMIC DILEMMA. *By Ernest Minor Patterson, professor of economics, University of Pennsylvania. Published by Whittlesey House, McGraw-Hill Book Company, 370 Seventh Ave., New York City; 1930. Cloth, 6x9 in.; 323 pages, charts, tables. Price, $3.50.*

IN A CLEAR and comprehensive manner, this book sets forth international economic conditions and tendencies. That the world is an economic entity is, as Professor Patterson points out, obvious to the most casual observer. That it is now in an economic dilemma is not so much due to a lack of recognition of universal economic interdependence as to the friction arising out of conditions of natural environment and man's innate characteristics. This friction is analyzed and certain remedies are suggested.

Among the "strains" on international economic relations considered by the author are the pressure of population, climate and natural resources, large-scale production, the gold standard, markets, corporate growth and investments, and the economic activities of governments. He then sets forth the various conditions in Great Britain, Germany, France, Italy, Japan and the United States and in the last chapter deals with the solution of the dilemma.

As Professor Patterson shows, the difficulties of the situation are of such magnitude and complexity that no single plan or scheme can afford a solution. Rather, the dilemma will be solved by co-ordinating all feasible plans and letting experience point the way. Among the schemes so far tried, Professor Patterson mentions commercial treaties, international cartels, financial consortiums, the International Chamber of Commerce and the League of Nations as the most promising.

The Degree Day

HEATING AND VENTILATING DEGREE DAY HANDBOOK. *Published by Heating and Ventilating, 521 Fifth Ave., New York City; 1930. Cloth, 6x8 in.; 58 pages, illustrated. Price, $1.50.*

THE DEGREE DAY has been found to be a very useful factor for computing the fuel consumption of heating systems. The degree day is a figure which is a product of one day times the number of degrees the average mean outside temperature is below 65 deg. This booklet describes how the degree day may be used for determining fuel consumption, and contains charts to aid such calculation.

It contains a table of degree days for each month of the year, in one thousand cities throughout the United States. From the data contained in these tables, a degree day map has been made for the United States, together with individual maps for various state groups. Degree day data and maps are also presented for the degree day based on 45 and 55 deg., instead of the standard 65 deg. normally used. This later data is particularly useful for factories and plants where the inside temperature is maintained at 60 instead of 70 degrees.

Brief Reviews

A STUDY OF WELDED METALS UNDER FATIGUE TESTS. First progress report by G. E. Thornton. Published as Bulletin No. 34 by the Engineering Experiment Station at State College of Washington, Pullman, Wash. 33 pages, illustrated.—A report of extensive research work, giving conclusions of practical interest to engineers using the various welding processes for machines and structures subjected to changing stresses.

ACCELERATED LABORATORY TEST FOR THE DETERMINATION OF SLACKING CHARACTERISTICS OF COAL. By A. C. Fieldner, W. A. Selvig and W. H. Frederic. Issued by the United States Bureau of Mines, Washington, D. C.; 24 pages, numerous tables.—A report of investigations of the slacking tendencies of low-rank coals, carried on at the Pittsburgh Experiment Station of the Bureau of Mines.

HYDRAULIC TURBINE GOVERNORS AND FREQUENCY CONTROL. Publication No. 13 of the National Electric Light Association, 420 Lexington Ave., New York City; 31 pages, illustrated; price, 75c.—A report of the N.E.L.A. Hydraulic Power Committee covering the fundamental principles underlying the design and operation of the hydraulic governor that may influence the application and operation of any method of frequency control.

WASHABILITY TESTS OF ILLINOIS COALS. By Alfred C. Callen and David R. Mitchell. Published as Bulletin No. 217 of the Engineering Experiment Station, University of Illinois, Urbana, Ill.; 114 pages, charts and tables; price, 60c.—Results of studies of the washing characteristics of Illinois coal, carried on by the Engineering Experiment Station in co-operation with the Zeigler Coal & Coke Company.

CHLORINATION OF CIRCULATING WATER. Issued by Wallace & Tiernan Products, Inc., Belleville, N. J.; 10 pages, illustrated.—Reprint of a report on the subject of chlorination by the National Electric Light Association.

COMBUSTION TESTS WITH ILLINOIS COALS. By Alonzo P. Kratz and Wilbur J. Woodruff. Published as Bulletin No. 213 of the Engineering Experiment Station, University of Illinois, Urbana, Ill.; 60 pages, charts and tables; price, 30c.—Results of tests to determine the burning characteristics of Illinois coals, carried on by the Engineering Experiment Station in co-operation with the Zeigler Coal & Coke Company.

DAS SCHRIFTTUM UBER KOHLENSTAUB. By O. Knabner. Published by the V.D.I. Verlag, Dorotheenstr. 40, Berlin NW 7, Germany; 116 pages; price, RM 6.—A bibliography of all literature published during the last decade on the use of pulverized coal as a fuel. It is issued as the 23rd report of the Committee on Pulverized Coal of the German National Coal Council.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

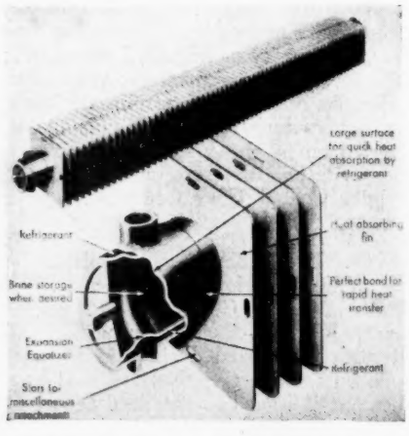
Grids to Replace Coils in Refrigerating Systems

DESIGNED for use in place of coils in mechanical refrigerating systems, Hydro-Thermal Grids, announced by the American Engineering Company, Philadelphia, Pa., are made with three sizes of fins and in a number of lengths.

A grid consists of an outer tube with fins inclosing an inner tube. The fins provide a large heat-absorbing area in small space, while the tube-within-a-tube construction spreads out the refrigerant in a thin layer between the concentric tubes and in contact with the large area of the outer tube. The refrigerant enters at one end of the tube; the heat-laden gas escapes at the other end. In no case is the gas travel greater than the length of a single grid. The inner tube can be filled with brine when a holdover is desired.

Both the tubes and the fins are of steel to preclude any possibility of electrolytic action between them. In addition to the fins being applied under heavy hydraulic pressure, producing a close frictional bond between the fin and tube for rapid heat transfer, the entire grid is hot-galvanized.

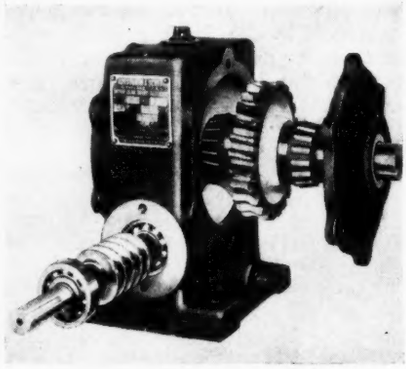
From the standard grids, which are available in a number of lengths, low-side units of any size and shape can be assembled.



Assembly and detail view of grid

Small Worm-Gear Speed Reducers

A LINE of small worm-gear speed reducers in two types, WB600 and WB700, is now being offered by the Horsburgh & Scott Company, Cleveland, Ohio.



Type WB600 speed reducer

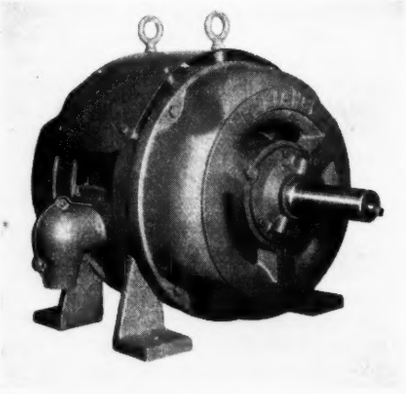
The units contained in the new line embody all the important features of the larger units made by the company. Some of these are, worm forged integral with the shaft; worm threads hardened, with the top, bottom and sides of threads ground after hardening; face of solid bronze worm gear extra wide, and use of radial thrust ball bearings on the worm shaft and tapered roller bearings on the gear shaft. The gear casing is made in one piece, with the gear and worm introduced through the sides, as shown in the illustration. Welded steel bedplates of suitable size to take the reducer and a direct-connected motor are also available.

Gear ratios range from $4\frac{1}{6}$ to 60, and the maximum torque on gear shaft in inch-pounds is given for the series WB600 as 1,100 lb., and for the WB7000 as 2,140 pounds.

Motors Protected With Drip Covers

THE Reliance Electric & Engineering Company, Cleveland, Ohio, has developed drip covers applicable to either the alternating- or direct-current motors it manufactures.

The covers are used to protect the motors in bad locations from dripping water, acid or other injurious solutions. They are made of heavy-gage sheet steel and are securely bolted to the frames in roof-like fashion, so that an opening is provided between motors and cover to permit free circulation of air.



Motor with cover in position

Semi-Automatic Dynamic Balancing Machine

THE EASE with which an 8-cylinder crankshaft can be balanced to within 0.05 oz.-in. illustrates the sensitiveness and accuracy of the special Olsen-Lundgren semi-automatic, electric spark dynamic balancing machine brought out recently by the Tinius Olsen Testing Machine Company, 500 North 12th St., Philadelphia, Pa.

Many differences in construction are evident between this balancing machine and the previous model. It does not, however, supersede the previous model, since there are many classes of work to which the older machine is peculiarly adapted.

Referring to the illustration, the

machine consists, essentially, of a vibrating frame carried on flexible members *A* slidably mounted on the base. The vibrating frame comprises two horizontal shafts, the roller brackets *B*, the center steady rest *C* for preventing excessive whip of long crankshafts, the driving means *D*, and the mechanism comprising the phase-angle shifter in the cabinet *E*. As many parts of the vibrating frame as practicable are made of aluminum, to reduce the inertia effect. This vibrating frame may be locked at F_1 or F_2 to obtain the amount of unbalance at either end of the crankshaft.

After a crankshaft is placed on the rollers and connection is made at the driving head, it may be locked at F_1 and the amount of unbalance at F_2 obtained. Rotation of the crankshaft at 250 r.p.m. is caused by throwing the switch *X*. Then, by turning on switch *G*, the sparking apparatus *H* comes into play, showing the angular position of unbalance in the shaft at the end F_2. The operator observes the mean of the angle of sparking arc. Switch *G* is then thrown off and switch *K* is thrown on, which shows the angular position of the compensating weight in housing *E*. Pressing the "forward" and "retard" buttons at *L* changes the angular position of the compensating weight with respect to the part being balanced.

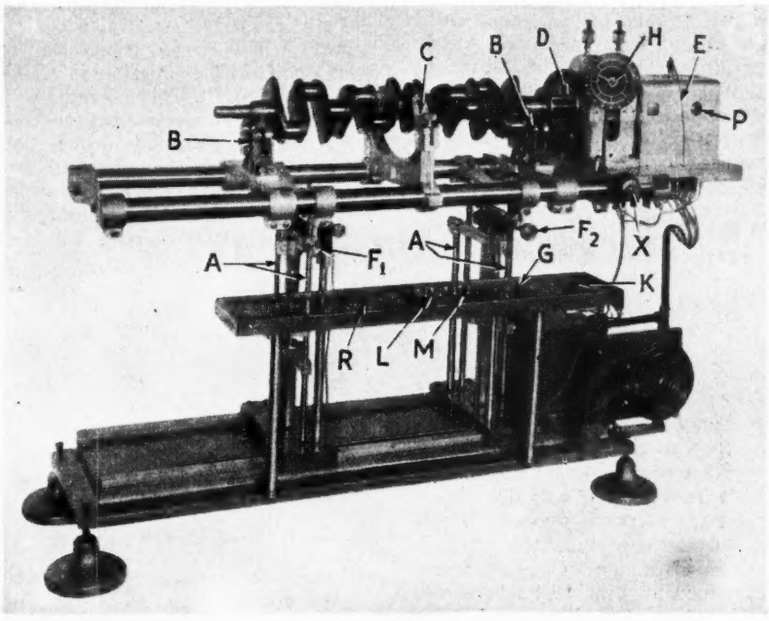
When the point of sparking for the compensating weight is brought around to the original sparking point, the compensating weight arm lies in the same plane as the plane of unbalance of the part being tested. Switch *K* is then thrown off and switch *G* is thrown on again, causing sparks on dial *H*. By depressing the buttons *M* alternately as necessary, a known weight in the weight holder is moved in and out radially to the drive shaft axis.

The previous operation having located and compensated for the plane of unbalance, this operation compensates for the amount of unbalance. When this weight is properly adjusted, the sparking ceases on dial *H*. The weight holder tube scale has a range of 20 oz.-in., and by means of a large vernier the unbalance can be read to 0.05 oz.-in. in the No. 3 size machine illustrated.

By turning the machine by hand until the axis of the compensating weight coincides with the hair line in the window at *P*, the part being balanced is brought to a position where the heavy side at the end being tested is toward the front of the machine and in a horizontal plane through the axis of the part. Having determined the amount and angular position of unbalance, the size and depth of drilling or other means of correction may be quickly determined by use of a suitable chart.

To obtain the unbalance at the other end of the crankshaft, it is locked at F_2 and switch *R* is used instead of switch *G*.

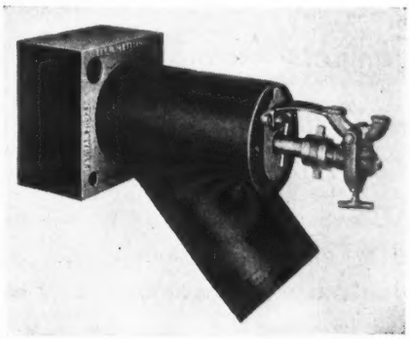
The machine is available in five sizes having the following capacities: No. 2, 10 to 50 lb.; No. 3, 30 to 175 lb.; No. 4, 150 to 750 lb.; No. 5, 500 to 2,500 lb.; and No. 6, 2,000 to 10,000 lb.



Olsen-Lundgren special semi-automatic, electric-spark dynamic balancing machine

High-Pressure Water-Cooled Burner

ADAPTABLE to a wide range of uses in the industrial field, the high-pressure water-cooled gas burner now being put out by Lee B. Mettler Company, 406 South Main St., Los Angeles, Calif., is made in a number of sizes and capacities and for burning gas, oil, or pulverized coal, separately or in combination.

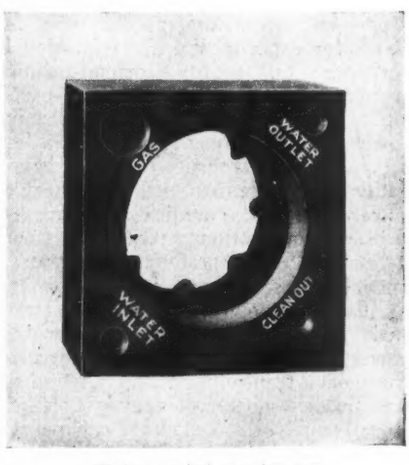


Burner assembly for combination fuel

The burner proper is made of heat- and corrosion-resisting material, and is arranged for water-cooling. Gas is supplied to the burner through a single inlet pipe, and delivered from a number of orifices placed around the circumference of an annular gas chamber. This gas chamber is completely surrounded by a water-cooling space of ample proportion, and so made that the outside of the burner is square.

The burner is offered in three sizes for 8, 6 or 3-in. pressure, air or pulverized-fuel connections. The gas inlets are 2, $1\frac{1}{2}$ and 1 in., the water connections 1, $\frac{3}{4}$ and $\frac{1}{2}$ in., respectively.

Each size of burner can be had with three sizes of gas orifice, $\frac{7}{16}$, $\frac{1}{4}$ and $\frac{1}{8}$ in., and with eight, six and four nozzles per burner. Capacities range from 160 to 24,000 cu.ft. of 1,000-B.t.u. gas per hour.



Water-cooled gas burner

NEWS of the FIELD

Congress Approves Conference Plan for Government Operation of Muscle Shoals

Allows one year for private leasing of fertilizer plants by President, who is expected to veto bill

ONCE MORE legislation providing for government operation of the Muscle Shoals power plant is before the President for approval. This time it is in the form of a compromise measure arrived at by conference between the two houses of Congress, which provides for the creation of a corporation functioning through a board of directors authorized to distribute surplus power equitably among states, counties, and municipalities within transmission distances, and for leasing the nitrate plants to a private corporation.

Agreement on the bill was reached by the Senate and House conferees on Feb. 18; the House passed the measure on Feb. 20 by a vote of 216 to 153, and on Feb. 23 the Senate gave its approval by a vote of 55 to 28. It is now before President Hoover, who is expected to veto it.

As passed by Congress the bill provides for the creation of a corporation to be known as the "Muscle Shoals Corporation of the United States," with authority to operate existing plants for experimental purposes for the manufacture of fertilizer or fertilizer ingredients; for donation of not exceeding 1 per cent of the total product of such plants for experimental and educational purposes to county demonstration agents and agricultural colleges; to allot to the Secretary of War certain power for use in operation of all locks, lifts, and other facilities in aid of navigation; and then to sell the surplus power to states, counties and municipalities, corporations, partnerships or individuals, with preference to states, municipalities, and counties and in order to place the government upon a fair basis for making sales of such surplus power, it shall have the authority to construct transmission lines, within transmission distance in any direction from Dam No. 2, and the steam plant; the bill also provides for the building of Cove Creek Dam, and an authorization of not to exceed $2,000,000 to begin its construction.

If signed by President Hoover, one year will elapse before the act becomes effective, during which he is given authority to lease all of the Muscle Shoals property for private operation of the nitrate plant for fertilizer manufacture. If a lease can be made, the power provisions of the act may never go into effect, for it is believed that the nitrate plants will consume all of the power available at Muscle Shoals, leaving little, if any, for sale and distribution to the general public.

In negotiating a lease with private interests for the manufacture of fertilizer, the President is given almost unlimited authority. The only restrictions placed on him are those pertaining to the quantity, quality, and selling price of fertilizer manufactured there. It is left wholly to his judgment to determine what rental shall be charged for the nitrate plant and other property mentioned in the bill, and the price for power to be paid by the lessee.

Muscle Shoals was acquired by the government in 1916, a year before the United States entered the World War. The question of disposition of the plant has been before Congress in various forms for more than ten years. Legislation somewhat similar to that incorporated in the present measure was pocket vetoed by President Coolidge in 1928. The present bill was passed by both houses of Congress in May, 1930, and disagreement between the Houses over certain details of the plan for disposition has kept the measure in conference since that time.

Urges House to Investigate Utility Holding Companies

REFERRING specifically to public utility holding companies, Walter M. W. Splawn, counsel for the House Committee on Interstate and Foreign Commerce, recommended Feb. 20 in his report on stock ownership of railroads, that the scope of the investigation originally authorized by the House into railroad holding companies should be broadened to include all holding companies engaged in interstate commerce. Pointing out that the holding company, as an agency in interstate commerce, is not confined to railway transportation but that its use has been more varied in other fields, Mr. Splawn stated that before deciding whether to regulate the holding company "in certain of its uses or abuses" the committee should be fully informed as to the exact nature of this device and what its economic advantages and disadvantages are with respect to the character of business in which it is used.

Investigation by the House committee into the status and operations of holding companies in the public utility field was advocated by Mr. Splawn to supplement the investigation that the Federal Trade Commission is conducting on behalf of the Senate. Mr. Splawn does not urge hasty enactment of legislation for regulation of the holding companies. Remarking that the commission's investigation will probably run for three years, he suggested that the vast quantities of data which that investigation has accummulated should be analyzed by the House committee just as, he said, the Senate committee will no doubt have the data in his report analyzed in connection with the findings of the Federal Trade Commission.

Symposium on Welding at A. S. T. M. Meeting, March 18

THE REGIONAL MEETING of the American Society for Testing Materials, to be held at the Hotel William Penn in Pittsburgh, Pa., March 18, will be devoted to a symposium on welding. Technical sessions will be held in the morning and afternoon, followed by a dinner in the evening at which a demonstration will be given of "The Electrical Production and Analysis of Sound and Music," by R. C. Hitchcock of the Westinghouse Research Laboratories.

Papers to be presented at the technical sessions include: "General Survey of Welding Processes," by F. T. Llewellyn; "The Quality of Materials for Fusion Welding," by C. R. Texter and F. N. Speller; "Modern Applications of Arc Welding," by A. M. Candy; "Recent Developments in Gas Welding and Cutting," by E. J. W. Egger; "Stethoscopic Examination of Welded Products," by J. R. Dawson; "Tests of Welding Made by the Watertown Arsenal," by Col. G. F. Jenks; "Magnetic Methods of

Testing Butt Welds," by T. R. Watts; "Fatigue and Impact Testing of Welded Products," by T. M. Jasper; "Welding Inspection," by R. Kraus. The Pittsburgh Section of the American Welding Society helped arrange the program.

New Boiler Goes on Line At Valmont (Colo.) Plant

PUBLIC SERVICE COMPANY of Colorado's new 21,398-sq.ft. boiler at the Valmont station, near Boulder, Colo., was officially put in service on Feb. 15, after two months' acceptance tests. With the completion of this boiler the capacity of the plant is raised to 45,000 kw. Installation of the boiler and accessory equipment and erection of the six-story structure housing it involved an expenditure of more than $750,000.

Modern in every respect, the boiler is capable of producing 275,000 lb. of steam per hour at a temperature of 426 deg. F. Pulverized fuel is used for firing, as in the other four units at the plant, and coal is supplied to the pulverizers by a screw conveyor which has a capacity of 100 tons per hour. Ashes are melted into slag and tapped off through the bottom of the furnace, which is completely protected by water walls.

Bill Urging Supervision of Steam Plants Again Introduced in N. Y. Legislature

Provides rigid code for all power and heating installations and registration of steam fitters

FOR THE THIRD TIME in successive years a bill to amend the labor law in relation to the installation and inspection of steam power and heating plants has been introduced in the New York State Legislature. This year it was brought up by Samuel H. Miller, Democrat of Oneida. Sponsored by labor interests, the measure aims at drastic supervision by the Department of Labor of all existing and future plants, whether in public or private buildings, and provides for the registration of all master steam fitters.

Under the terms of the act, a division of steam power and heating plants would be created in the Department of Labor, to be headed by a practical man of not less than ten years' experience in steam plant work. His duties and pay are to be determined by the industrial commissioner, who will appoint other employees needed for carrying out the provisions of the measure. The industrial board of the department shall prescribe a code for the installation, alteration and equipment of steam power and heating plants; applicable to plants now installed, to be installed, and the alterations to existing and future plants. It shall include specifications covering materials, workmanship and manner of executing such work.

Before any construction or alteration of existing buildings may be authorized by any local authority, the plans for the installation and alteration of the steam power or heating plants shall be submitted to the industrial commissioner for approval. A ten dollar fee must accompany all such plans. Furthermore, according to the act, no steam plant hereafter installed shall be operated until approved by the industrial commissioner. The commissioner also has the authority to order any existing plant not constructed in accordance with the code to be so altered as to conform thereto, but the owner of the property has the right of review of such order by the board. Rigid inspection of all plants is prescribed for carrying out the provisions of the measure, and any person violating it shall be guilty of a misdemeanor.

The bill further provides for the registration of all master steam fitters with the industrial board at a fee of five dollars. Registration must be renewed the first of every year without payment of further fee. Each registrant will reeiver a card, which must be kept and exhibited whenever asked for. Failure to have a certificate of registration while on the job makes the master steam fitter guilty of a misdemeanor and liable to a fine of $100. A public record of registration will be kept, and certificates may be revoked for cause after a proper hearing. A revoked certificate will not be renewed within the period of a year.

If passed, the act would go into effect July 1, 1931. It is similar in every detail to a bill introduced last year by Assemblyman William F. Condon, Republican of Yonkers.

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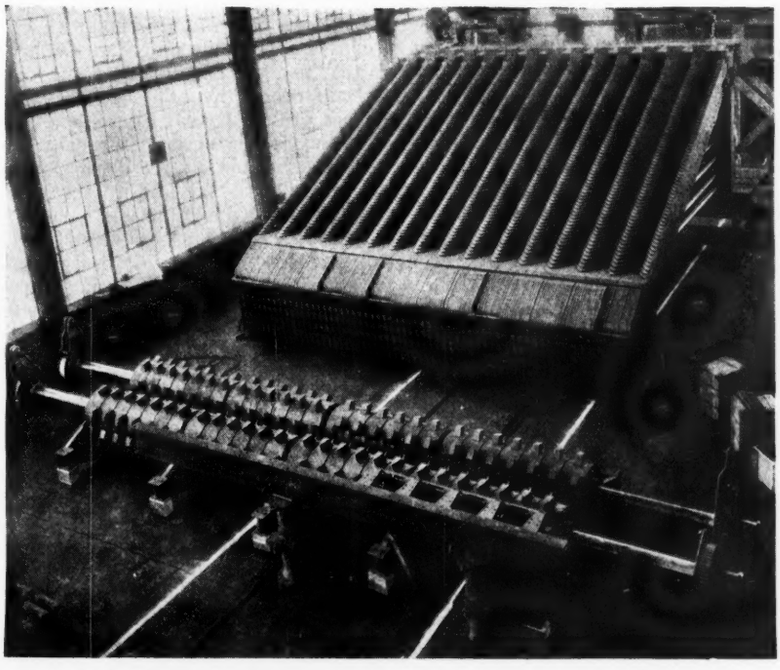
LONGEST STOKERS FOR HUDSON AVE.

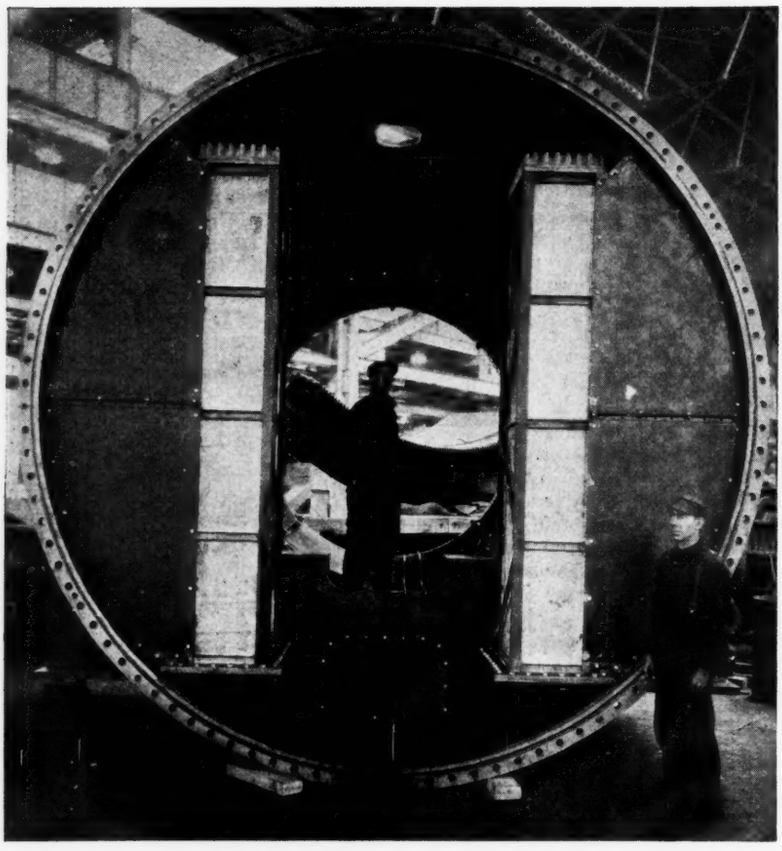


One of eight Taylor stokers ordered for the Hudson Avenue station of the Brooklyn Edison Company, being assembled at the shops of the American Engineering Company of Philadelphia. These 15-retort, 69-tuyére stokers, measuring approximately 27 ft. long and 26 ft. wide, are the longest underfeed stokers in the world. A radical departure from the ordinary means of actuating the secondary feed rams is one of their features. Each pusher rod has been brought out to the front of the stoker where the stroke can be individually adjusted. Driven by a hydraulic pump and motor, each stoker will be capable of burning 28.3 tons of coal per hour at maximum rating

Hoover Dam Bidders Finish Field Studies

REPRESENTATIVES of several contracting firms that anticipate bidding for the construction of Hoover Dam and its accessories, the biggest contract ever advertised by the government, have finished their field studies on the ground and have departed, according to the latest information received by Secretary Wilbur. An indication of the widespread interest among contractors in this huge job in the desert is furnished by the fact that 196 copies of the specifications have been sold for $5 a copy.

50,000-KVA. HYDROGEN-COOLED CONDENSER



Giant surface cooler for a 50,000-kva. hydrogen-cooled synchronous condenser in the Schenectady works of the General Electric Company, where it was manufactured for the Southern California Edison Company's outdoor installation at the La Fresa substation. This unit is by far the largest hydrogen-cooled synchronous condenser ever built

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Utilities Fight Hydro Tax in South Carolina

THE PROPOSED TAX on hydro-electric power was opposed and branded as a threat to the future prosperity of the State at a recent hearing before the ways and means committee of the South Carolina House of Representatives at Columbia.

J. H. Marion, counsel for the Duke Power Company interests, declared: "No more dangerous taxation has even been proposed for South Carolina." W. S. Lee, vice-president and chief engineer of the Duke organization, declared that the tax, if levied, as proposed, would tie the hands of the power interests and halt their future development in South Carolina.

He gave figures to show that his company paid in South Carolina taxes in 1928 approximately $750,000; in 1929, $821,000; in 1930, $840,000. In a normal year the proposed tax would mean about a half million more on his company, he said, such a burden would be overwhelming. "Keep this up six more years and you will own the power companies," he declared. "This tax will mean we have to withdraw investments in South Carolina."

T. C. Willams, vice-president of the Lexington Water Power Company, stated that had such a tax been in force in 1927, the Saluda Dam would never have been built. If this tax goes into effect, the Santee plant will never be built by the Barstow interests, he said.

Water-Power Development Over 1,000,000 Hp. in 1930

TOTAL CAPACITY of water wheels at hydro-electric plants in the United States on Jan. 1, 1931, according to the annual report just released by the Department of the Interior through the Geological Survey, was 14,884,667 hp., an increase of 1,076,889 hp., or 7.2 per cent, during 1930. This increase has been exceeded only in 1929 and 1926, when the increases were 1,276,000 and 1,138,000 hp., respectively. These figures indicate that the utilization of the country's water-power resources is proceeding at a fair rate, notwithstanding the continued improvement in the efficiency of steam plants. The states that show an increase of about 100,000 hp. each during the year are widely distributed—New Hampshire, New York, South Carolina, Tennessee, Alabama, and Washington.

	Jan. 1, 1930	Jan. 1, 1931	Increase, Per Cent
New England...	1,642.670	1,897,591	16
Middle Atlantic.	2,113,313	2.211,663	5
East No. Central	1,075,434	1,092,414	2
West No. Central	551,102	566,766	3
South Atlantic..	2.657,289	2,918,379	10
East So. Central	1,168,992	1,363,653	17
West So. Central	49,237	49,237	0
Mountain.....	1,184,528	1.217,388	8
Pacific.....	3.365,213	3,567,576	6
United States Total.....	13,807,778	14,884,667	7

The accompanying table shows the total capacity in horsepower of water wheels in different section of the United States on January 1, 1930 and 1931, and the increase during 1930.

Arizona Insists on Right To Bring Hoover Dam Suit

INSISTING ON ITS RIGHT to bring suit in the United States Supreme Court against the Secretary of the Interior and six interested states to prevent the construction of the Hoover Dam project, the State of Arizona filed a brief with the court on Feb. 21, opposing the motion of the secretary and states to dismiss its suit.

The grounds for dismissal advanced in the motions of Secretary Wilbur and the states are: (1) The bill does not join the United States, which is an indispensable party to this suit; (2) the proposed acts of the defendants will not invade any vested rights of the complainant or of any of its citizens; (3) the bill presents only abstract questions which may never arise in any justiciable case or controversy; and (4) upon the allegations of the bill and in view of the facts of which the court will take judicial knowledge, the Boulder Canyon Project Act is clearly constitutional, and the acts of the secretary pursuant to its terms cannot give rise to any cause of action.

In its brief Arizona states that its suit is not "against the United States, nor one involving sovereign or property rights of the country. It is a suit to enjoin an officer of the United States from invading, under color of an unconstitutional enactment, quasi-sovereign rights of Arizona. It presents a justiciable case within the jurisdiction of this court:

"Arizona has a quasi-sovereign interest in all the water and land within its borders, which it may protect by suit in this court. Defendant Wilbur threatens to invade that right and injure Arizona by constructing works within Arizona to dam and permanently divert water flowing in Arizona and used elsewhere, and, by these works and by enforcing the Colorado River compact, to prevent any beneficial use of Colorado River water now flowing in Arizona and

subject to appropriation there. There are existing projects to use great amounts of this water, the execution of which Defendant Wilbur is preventing. His acts will cause great areas of Arizona which are susceptible of cultivation to remain forever unproductive and uninhabitable."

Hall Discusses Feed-Water Control Before A.S.M.E.

FUNDAMENTALS OF FEED-WATER CONTROL to protect boilers from scale, corrosion, and embrittlement, were outlined by R. G. Hall, director of the Hall Laboratories, Inc., on Feb. 24 before the Metropolitan Section of the A.S.M.E. Among the important practical conclusions presented was the recommendation that feed water be admitted to a trough above the water in the rear drum of bent-tube boilers.

Dr. Hall told of cases where severe corrosion had been eliminated by shifting the feed point from the lower drum to the trough in the upper rear drum. The effectiveness of this change, as explained by Dr. Hall, arises from the fact that feed water spilling from the trough is violently agitated by steam leaving the water in the drum. This steam, he said, tends to deaërate the water before it has opportunity to corrode drums and tubes. He showed that admission of feed water at a point where circulation is stagnant permits bubbles to form at the surface and creates a tendency to corrosion if any oxygen is present in the water.

Speaking of so-called caustic embrittlement, Dr. Hall declared that calking only is the most reliable mechanical protection that can be given to a boiler. Another sure protection is the maintenance of the sulphate-alkalinity ratios prescribed in operating codes.

Investigation Started of Pennsylvania Commission

FOLLOWING THE DEMAND of Governor Pinchot for a "thorough-going investigation of public utilities in Pennsylvania," the State Senate has appointed a committee to inquire into the activities of the Public Service Commission, and hearings have already begun. At the same time the House has passed a resolution providing for a separate investigation of the commission and the utilities by a committee composed of seven members of the House and three to be appointed by the Governor.

The Senate Committee heard testimony from John Fox Weiss, former chief counsel for the commission, and Dr. F. Herbert Snow, chief engineer of the commission, both of whom testified that the commission had served the public and the utilities and that it was "free from utility domination or improper influence."

Governor Pinchot, who has agreed to appear at the hearings and assist the inquiry in every way possible, has proposed a number of questions which he said the committee might well investigate. Among these the following apply directly to power utilities:

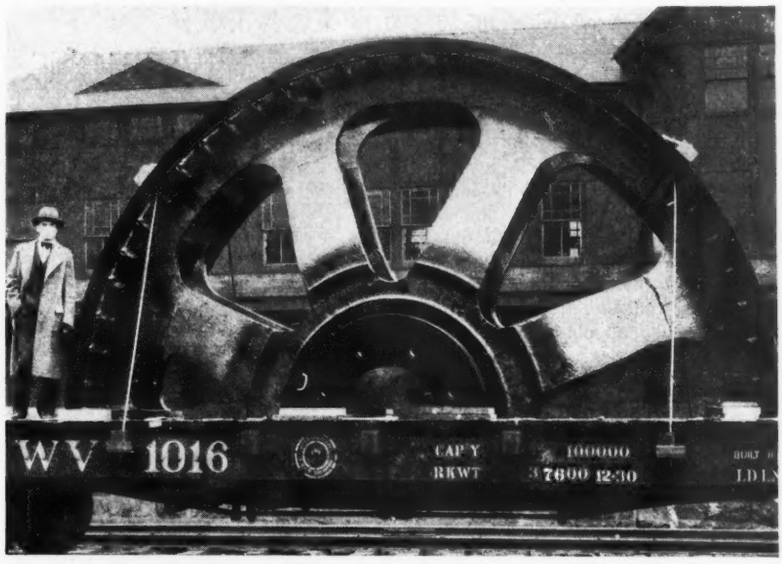
"Why does the electric company in Worcester, Mass., importing its coal over 400 miles, charge a 5-cent rate to domestic consumers, while the people of Pennsylvania, living close to the coal fields, pay from 50 to 100 per cent more; for example, Pittsburgh 7c., Philadelphia 7½c., Erie 8c., Harrisburg and many other cities 10 cents?

"Why have the people of Jamestown, N. Y., just outside our border, been paying 4c. for domestic lighting, when many of our people pay from two to three times as much?

"How many million dollars are the people of Pennsylvania required to pay the public utilities each year beyond a fair return on the money actually invested.

"Is it true that the light and power utilities of Pennsylvania are owned outside the State to such extent that one man in New York controls the electricity supplied to one-third of our Commonwealth?"

GENERATORS FOR NEW BAGNELL DAM



Half of the 310,000-lb. rotor of one of the generators for the new Bagnell Dam plant, ready for shipment from East Pittsburgh

FIRST SHIPMENTS on a million dollar order for water-wheel generators, to be used at the new Bagnell Dam on the Osage River, Mo., are being made from the Westinghouse Electric & Manufacturing Company to the Union Electric Light & Power Company. These six generators are to be of the so-called outdoor type and will be built into the foundation of the spillway. Instead of the usual power house, the units will simply be covered with large cast iron lids and these will be removed as desired by a large traveling crane. Only the controls will be housed inside of rooms built into the wall of the dam.

In operation, the generators will become a part of the 201,000-hp. development on the Osage, the Bagnell Dam being a structure 148 ft. high from bedrock to highway, changing the river into a huge lake reservoir 129 miles long, with an area of 95 square miles and 1,300 miles of shoreline. In the development of this reservoir, it has been necessary to move an entire town four miles to higher ground to avoid obliteration.

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Canadian Central Station Output Grows 2% in 1930

OUTPUT OF CENTRAL STATIONS in Canada increased 2 per cent in 1930, approximately 8 per cent less than the growth in immediately preceding years. This output which includes power generated both by fuel and water, amounted to 17,828,121,000 kw.-hr., as compared to 17,632,876,000 in 1929 and 15,931,447,000 in 1928. By far the greater proportion of the output was derived from water power, which in 1930 amounted to 17,525,363,000 kw.-hr. From fuel only 302,758,000 kw.-hr. were produced.

Leaving aside the almost negligible amount of fuel-generated electricity, the following totals show comparisons by regions between 1930 and the previous year in the amount of water-power-generated electricity produced by central stations. Three regions, the Maritime Provinces, Quebec, and British Columbia, show increases, while two, Ontario and the Prairie Provinces, show decreases from the previous year. In the Maritime Provinces, though the output is small compared to Ontario and Quebec, the increase in recent years

has been quite noteworthy. In 1930 the output from central stations from water power amounted to 469,517,000 kw.-hr. as compared with 185,501,000 in 1929, or an increase of 150 per cent.

In Quebec, where power development in recent years has been little short of phenomenal, the output of central stations from water power in 1930 amounted to 8,786,489,000 kw-hr., as compared to 8,677,204,000 in 1929. A slight falling off, probably due to industrial curtailment, is shown for Ontario, which ranks second to Quebec in point of water-power development. In 1930, the output amounted to 5,988,-381,000 kw-hr., as compared to 6,145,-166,000 in 1929.

The output of electricity generated by water power in the Prairie Provinces was also lower in 1930 than in 1929. The production amounted to 1,122,215,-000 kw.-hr. as compared to 1,216,415,-000 in 1929. In British Columbia, where water-power development is steadily becoming a most important factor in the economic growth of the province, a similar comparison shows the 1930 output as totalling 1,158,761,-000 kw.-hr., as compared to 1,077,127,-000 in 1929. The increase for the last quarter of 1930 was particularly noteworthy, amounting to about 80 per cent of the gain for the whole year.

Obituary

HARRISON S. BOWEN, prominent mechanical engineer, of Chicago, died at Wilmette, Ill., on Feb. 14. Since 1896 Mr. Bowen has been connected with the Robert W. Hunt Company as mechanical engineer. He was born at Des Moines, Iowa, in 1872; graduated from Iowa State College in 1894 and from Cornell University in 1895 in mechanical engineering. In his work with the Robert W. Hunt Company, Mr. Bowen was engaged in the investigation and efficiency testing of all kinds of power units. This work covered such important installations as the Chicago water works pumping stations and drainage pumping station units. The mechanical efficiency testing work on heating and power plants under the charge of Mr. Bowen was a pioneer work in the Chicago area. Many hundreds of installations were reviewed and tested and brought to the highest state of mechanical and fuel consumption uses. He was a member of the American Society of Mechanical Engineers and the Westren Society of Engineers.

HARRY M. MONTGOMERY, mechanical engineer, died suddenly Feb. 14, of a heart attack in his home at 1408 Dempster St., Evanston, Ill. He was 69 years old. Mr. Montgomery was born in Lafayette, Ind. He studied at the Massachusetts Institute of Technology in Boston, and later was affiliated with a Chicago firm in the development of pumps and hydraulic condensers. Mr. Montgomery served as a major in the quartermaster corps during the world war and was in charge of construction at Jefferson City and St. Louis. He was a member of the American Society of Mechanical Engineers, the Engineers Club of New York City, the Chicago Engineers Club and Technology Club.

COMING CONVENTIONS

American Society of Mechanical Engineers. Semi-annual meeting in Birmingham, Ala., Apr. 20-23. Meeting at Hartford, Conn., June 1-3. National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 15-16. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting in Pittsburgh, Pa., March 11-13. District meeting in Rochester, N. Y., Apr. 29-May 2. Annual summer convention in Asheville, N. C., June 22-26. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Spring meeting at the Hotel President, Kansas City, Mo., May 6-8. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting in New York City, Apr. 22-24. Secretary, M. M. Kelly, 33 West 39th St., New York City.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 18-19. Secretary, Dorothy A. Texter, Oliver Building, Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual meeting and exposition at the Cleveland Public Auditorium, Cleveland, Ohio, June 15-19. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

1931 Midwest Bituminous Coal Conference. To be held at the University of Illinois, Urbana, Ill., May 21-22. Chairman of Program Committee, B. R. Gebhart, Illinois Coal Bureau, 307 North Michigan Ave., Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

National District Heating Association. Annual convention at the Hotel Statler, Boston, Mass., June 2-5. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 8-12. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

Personals

C. L. KARR, formerly superintendent of power of the Kansas Gas & Electric Company of Wichita, has been appointed operating manager of the Carolina Power & Light Company with headquarters at Raleigh, N. C. He will have charge of all operating departments of the company, which serves considerable portions of North and South Carolina. Before joining the Kansas Gas & Electric, Mr. Karr spent ten years with the Detroit Edison Company as chief assistant engineer.

W. H. LESSER, since 1917 mechanical engineer in the operating department of Madeira, Hill & Company's anthracite mines, has been appointed combustion and mechanical engineer of the recently organized Penn Anthracite Collieries Company of Scranton, Pa. In his new position, Mr. Lesser will devote much time to the combustion problems of the company's coal consumers. Previous to his connection with the Madeira company, he was operating mechanical engineer for the Philadelphia & Reading Coal & Iron Company.

H. B. VILLIERS, specialist in the elimination of vibration and noise, has been appointed head of the recently created department of natural cork isolation of L. Mundet & Son, Inc., New York City.

OSCAR A. ANDERSON, supervising engineer of Armour & Company, was recently elected chairman of the Chicago Section of the American Society of Refrigerating Engineers. Other officers elected were: vice-chairman, GEORGE F. MCDONALD, engineering department of the Cudahy Packing Company; secretary and treasurer, B. E. SEAMON, president of the Westland Engineering Company.

ROBERT B. GROVE, secretary of the United Electric Light & Power Company, one of the five companies composing the New York Edison system, was recently elected a vice-president of the company. In June Mr. Grove will complete 25 years with the company, having started as a draftsman. MELVILLE T. CHANDLER, assistant secretary, was made secretary to succeed Mr. Grove, and JOHN H. AIKEN, executive assistant, was made assistant secretary.

REID H. GARDNER, former assistant general manager of the Dixie Power Company, Cedar City, Utah, has been appointed vice-president and general manager of that company to succeed A. L. WOODHOUSE, who resigned recently. P. R. LARSON was appointed to succeed Mr. Gardner as assistant manager.

D. C. PRINCE has been appointed engineer of the switchgear department of the General Electric Company at Philadelphia, which includes supervision of switchgear research at Schenectady.

Business Notes

GIRTANNER ENGINEERING CORPORATION, New York City, announces that it has become a part of the Wilbur G. Hudson Corporation of the same city, but will continue to operate under its own name as heretofore. Officers of the new combination are W. W. Burden, president; Alexander Girtanner, vice-president and general manager; and J. A. Robinson, chief engineer. The same personnel has been retained, and with the addition of the engineering and sales staff of the Hudson company, the Girtanner corporation has broadened its activities and is now engaged in development work that will soon be reflected in new equipment lines, it is stated.

YEOMANS BROTHERS COMPANY, Chicago, Ill., announces the appointment of the Jackson Engineering Company, 934 Architects and Builders Building, Indianapolis, Ind., as its representative in that territory.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., announces that beginning this week it will omit Saturday operations, except as involved in maintaining adequate service with customers and others with whom the company does business. This amounts to a 10 per cent reduction in operations, it is stated, and will apply to all salaried employees. It is emphasized in the announcement that this arrangement is solely an emergency measure to spread the work through this period of severe business depression and that normal arrangements will be reinstated with the advent of normal times.

AFFILIATED ENGINEERING COMPANIES, LTD., Montreal, Canada, announces the removal of its Montreal offices from the Southam Building to Suite 1606 University Tower, 660 St. Catherine St., West, on March 1. It is also announced that several new accounts have been added and the complete list now includes the American Engineering Company, Taylor Stoker Company, Bernitz Furnace Appliance Company, Coppus Engineering Corporation, Andale Engineering Company, Allen & Billmyre Company, James MacIntosh & Company, Victory Valves Limited, Thomas Clarkson, Ideal Commutator Dresser Company, Ernst Company, National Company, Ellis Drier Company, Keystone Refractories Company, Terminal Engineering Inc., Frank H. Paquin Company, Rolland Gardner & Company, Vulcan Soot Cleaner Company, Canadian Kellogg Company, B. G. Carpenter Company, and Troy Engine & Machine Company.

J. E. RHOADS & SONS, Philadelphia, Pa., announces that Wayne Davies, formerly manager of leather sales for E. F. Houghton & Company, has joined its sales organization. Mr. Davies has had a wide experience in the fields of power transmission, conveying machinery and hydraulic packing design.

How's Business?

TELESCOPES trained on foreign affairs yield more for the optimist this week than do economic microscopes examining domestic movements. Fumbling gestures toward closer European cooperation, in politics, in agricultural problems, in finance, and a slight upturn in British prices may be significant straws. Abandonment of our embargo efforts may be counted among these constructive international indications. At home there is still no decisive evidence of business change. Our index is practically stationary at 78.2% of normal, about the average level of the past two months. Steel activity shows no sign of marked increase in demand from the big consuming industries, and spring automobile sales prospects are still uncertain. Strengthening of raw cotton prices, textile demand, and residential building projects has begun to stir some enthusiasm, but spring fever is probably a sufficient explanation of the rise in stock market prices and activity, perfectly paralleling last year's. —*The Business Week*, March 4.

Trade Catalogs

MISCELLANEOUS EQUIPMENT—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has recently issued the following new bulletins: D.M.F. No. 5258, on new developments in condensing equipment for marine application; D.M.F. No. 5299 on the use of steam-jet air ejectors in industries using vacuum processes; L-20426 and L-20447, on single- and two-stage motor-driven and turbine-driven condensate pumps; Circular 1835-A, on 3,600-r.p.m. steam turbine-generator units; Leaflet 20477, on dual-drive exciter sets from 25 to 500 kw. capacities; Circular 1886, on dry-type transformers and auto-transformers; Leaflet 20512, on Type A circular-chart electrical recording instruments; Leaflet 20439, on induction motors for power-plant auxiliaries.

ELECTRICAL EQUIPMENT — General Electric Company, Schenectady, N. Y., has recently issued the following new catalogs: GEA-1337, covering small synchronous condensers; GEA-820A, covering vertical water-wheel-driven generators from 62.5 to 3,000 kva. capacities; GEA-1239, covering miniature electrical instruments; GEA-1135A, covering rectangular switchboard electrical instruments; GEA-970B, covering Type PQ relays; GEA-1341, covering totally enclosed fan-cooled induction motors for hazardous locations; GEA-782C, covering outdoor switch houses; GEA-703A, covering station oil circuit breakers; GEA-831A, covering manually operated field switches; GEA-1128A, covering steel-panel switchboards; GEA-311A, covering the G-E CR2990-5 thermostat; GEA-1351, covering automatic tank and pipe welder; and GEA-1311A, covering electric brazing equipment.

PISTON METAL — An illustrated description of the use of "Allan Red Metal" for facing the pistons of reciprocating engines, compressors, and pumps, is contained in a recent publication, entitled "The Heart of the Engine—The Seat of Power," issued by A. Allan & Son, 601 Bergen St., Harrison, N. J.

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Fuel Prices

FUEL OIL

New York—Feb. 26, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, contract, 6c. per gal.

St. Louis—Feb. 11, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.339 per bbl., or 42 gal.; 26@28 deg., $1.464 per bbl.; 28@30 deg., $1.589 per bbl.; 30@32 deg., $1.689 per bbl.; 32@36 deg., gas oil, 3.776c. per gal.; 38@40 deg., distillate, 4.526c. per gal.

Pittsburgh—Feb. 18, f.o.b. local refinery, 34@36 deg., fuel oil, 3.125c@ 3.5c. per gal.; 36@40 deg., 3.125c.@3.5c.

Philadelphia — Feb. 2, No. 4, light, $1.31 per bbl.; No. 5, medium, $1.22; No. 6, heavy (Bunker C) $1.10.

Cincinnati—Feb. 17, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—Jan. 16, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 60c. per bbl.; 22@26 deg., 67.5c. per bbl.; 26@30 deg., 80c. per bbl.; 30@32 deg., 95c. per bbl.; 32@36 deg., gas oil, 2.25c. per gal.

Boston—Feb. 24, tank-car lots, f.o.b. 12@14 deg., Baumé, 2.95c. per gal.; 28@ 32 deg., 5c. per gal.

Dallas—Feb. 21, f.o.b. local refinery 24@26 deg., $1.10 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.90 @ $2.25
Pool 10, h. gr. low-vol.	New York	1.75 @ 1.85
Pool 11, low-vol.	New York	1.60 @ 1.75
Smokeless, mine-run	Chicago	1.75 @ 2.25
Smokeless, slack	Chicago	.75 @ 1.35
Harlan, Ky., slack	Chicago	.70 @ 1.00
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.50 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.20 @ 1.75
Standard Ill., mine-run	St. Louis	1.50
W. Ky., mine-run	Louisville	.90 @ 1.25
W. Ky., slack	Louisville	.55 @ .70
Pittsburgh, mine-run	Pittsburgh	1.35 @ 1.45
Smokeless, mine-run	Cincinnati	1.75 @ 2.25
Smokeless, slack	Cincinnati	.85 @ 1.35
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.50 @ .85

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.50
Barley	New York	1.50

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Fairfield—City plans an election soon to vote $38,600 bonds for waterworks improvements, including additional wells, deep well pump, new water mains, etc.

Calif., Palo Alto—City is having plans and estimates made for improvements to municipal light and power plant, probably including Diesel oil engine installation. Burns & McDonnell Engineering Co., 406 Interstate Bldg., Kansas City, Mo., is engineer.

Calif., San Francisco—State Board of Harbor Commissioners, had plans prepared for doubling capacity of shipside refrigeration facilities. Estimated cost $100,000. F. G. White, Ferry Bldg., is engineer.

Ill., Chicago—Graham, Anderson, Probst & White, 80 East Jackson Blvd., Archts., will soon receive bids for first unit of 42 story office and stores building at La Salle and Adams Sts., for Marshall Field Estate, 231 South La Salle St. Estimated total cost $5,000,000.

Ill., Itasca—City awarded contract for the construction of a pumping plant, etc., in connection with sewage treatment work to Giellefeld Consruction Co., Forest City, Ia. $136,075.

Ind., Washington—Municipal Light & Power Co., will soon award contract for addition to power plant including equipment. Estimated cost $43,000. Private plans.

Kan., Kansas City—Bd. of Public Utilities, C. A. Lowder, Secy., awarded contract for the construction of a 94 x 130 ft. power plant at Quinpaw water plant to Wyatt & Barcus, 1609 Nebraska St., Kansas City, Mo., $196,615. Contract let for equipment including re-actors, signal system, lightning arresters, switch structure, etc.

Ky., Harlan—City is having plans prepared for the construction of a complete new power plant. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., is engineer.

La., Opelousas—City awarded contract for furnishing and installing a 960 to 1,000 hp. Diesel engine, including motor generator and exciter to Busch Sulzer Bros. Diesel Engine Co., Opelousas. Estimated cost $48,990.

Md., Betterton—Royal Swan Corp., Fuller Bldg., Philadelphia, Pa., awarded contract for a 3 story hotel and amusement building here to I. M. Cirrito & Co., Bryn Mawr, Pa. Estimated cost $1,000,000. Steam heating system, etc., will be installed.

Mass., East Longmeadow — Central Massachusetts Electric Co., M. MacGeachey, 406 Main St., Palmer, plans the construction of a power sub-station here. Estimated cost $50,000. Private plans.

Mass., Reading—Dept. of Public Works, plans the construction of a pumping station near Grove St. Estimated cost $50,000. Architect not selected.

Minn., Minneapolis — Minneapolis Columbus Club Inc., Elks Bldg., E. J. Loring, Chn. of Building Comm., 642 McKnight Bldg., will soon receive bids for the construction of a 12 story club and hotel, including steam heating system, swimming pool, etc., at 12th St. and LaSalle Ave. Estimated cost $1,000,000. Bertrand & Chamberlin, 616 Civic & Commerce Bldg., are architects.

Minn., Redwood Falls—City, F. B. Forbes, Clk., is having preliminary plans prepared for waterworks improvements, including reservoir, pump house, pumping equipment, etc. L. P. Wolff, 903 Glove Bldg., St. Paul, is engineer.

Mo., St. Louis—Bd. of Public Service, 208 City Hall, will receive bids until Mar. 17 for the construction of a 6 story nurses' home including steam heating and ventilation systems, elevator, etc. Estimated cost $556,000. A. Osburg, 301 City Hall, is architect, and L. R. Bowen, 301 City Hall, is engineer.

N. H., Concord — City Water Commission, awarded contract for the construction of Soucook River pumping station to Norquist Construction Co., Inc., 80 South Main St. Estimated cost $15,000.

N. J., Beach Haven—Jersey Central Power & Light Co., Toms River, will build a gas plant and storage tanks on Brighton Beach here. Estimated cost $40,000. Private plans. Work will be done by separate contracts.

N. J., Carlstadt — Carlstadt Consumers Ice Co., 501 11th St., awarded contract for remodeling and renovating ice plant to Frick & Co., Waynesboro, Pa. Estimated cost $40,000. Machinery and equipment will be required.

N. J., Princeton — Nassau Tavern Inc., awarded contract for the construction of a hotel to Matthews Construction Co., 285 Madison Ave., New York, N. Y. Estimated cost $1,000,000. Steam heating and ventilation systems, boilers, elevators, etc., will be installed.

N. Y., New York — Academy Construction Corp., c/o Springstien & Goldhammer, 40 East 49th St., Archts., will build an apartment building at Commonwealth, Lacombe and Rosedale Aves. Estimated cost $2,000,000. Work will be done by day labor and separate contracts.

N. Y., New York — Anniston Realty Corp., 130 West 42nd St., will build an apartment and stores building at Morris and Clay Aves. Estimated cost to exceed $1,000,000. E. L. Larkin, 130 West 42nd St., is architect. Work will be done by day labor and separate contracts.

N. Y., New York—New York Dock Trade Facilities Corp., subsidiary of New York Dock Co., 44 Whitehall St., plans the construction of an office building at Broadway, Corland, Church and Dey Sts. Estimated cost to exceed $15,000,000. Maturity about 1932.

O., Canton—Bd. of Control, plans improvements to waterworks, including sinking of several wells and enlarging water pumping facilities. Estimated cost $160,000. W. E. Sarver is engineer.

Okla., Hominy—City, G. H. Blackwood, Clk., will receive bids about April 1 for the construction of a power plant. Estimated cost including equipment $150,000. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, are engineers.

Okla., Norman — Quix-Kold Corp., C. C. Beasley, Pres., 408 Oklahoma Savings Bldg., Oklahoma City, awarded contract for the construction of a plant for the manufacture of dry ice to J. Kennedy, Norman. Estimated cost including equipment $45,000. Equipment contracts let.

Ore., Eugene — Medical Arts Association, awarded contract for a 12 story office building at 8th and Willemette Sts. to Hargrass & Lindsay, Eugene. Estimated cost $500,000. Steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc., will be installed.

S. C., Aiken — City will receive bids about Mar. 1 for extensions and improvements to light and power plant including Diesel oil engine. Burns & McDonnell Engineering Co., 406 Interstate Bldg., Kansas City, Mo., is engineer.

Tenn., Memphis — U. S. Veterans Bureau, Washington, D. C., will receive bids until Mar. 17 for construction of a boiler house, chimney, etc., here.

Tex., Galveston—Gulf, Colorado & Santa Fe Ry. Co., will receive bids until Mar. 3 for the construction of 8 and 11 story additions to office building, including 29 x 52 ft. boiler house, etc. Estimated cost $1,000,000. K. B. Duncan is chief engineer.

Tex., Kilgore—City plans the construction of a complete waterworks system including pumping unit, distribution mains, etc. Estimated cost $50,000.

Tex., Wharton—City will soon award contract for waterworks, improvements including well, pump house, etc. J. C. McVea, 426 Esperon Bldg., Houston, is engineer.

B. C., Vancouver—Northwestern Power Co., E. Anderson, Pres., 200 Electric Railway Chambers, Winnipeg, Man., is having plans prepared for the construction of a 1 story, 36 x 90 ft. electric sub-station here. Estimated cost $300,000.

Ont., London—Kellogg Co. received lowest bid for the construction of power house from Hyatt Bros., 290 Egerton St. $150,000.

Equipment Wanted

Alternator—Sydney, New South Wales, Australia—Government Railways, will receive bids until Apr. 8 for one 2,500 kw. alternator for Lithgow power station.

Boilers, Engines, Motors, etc. — Vancouver, Wash.—Washington Canners Co-Operative Association, plans to purchase boilers, engines, motors, cold storage equipment, etc., for proposed 1 story, 100 x 100 and 80 x 370 ft. cannery and cold storage plant. Estimated cost $75,000.

Generator Sets—Boston, Mass.—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Mar. 11 for motor generator sets and switchboards here.

Generator Unit—Pasadena, Calif.—City will receive bids until Mar. 16 for a 25,000 kw. steam turbine electric generator unit, for municipal power plant.

Motors and Boilers — Montreal, Que. — Canadian Crown Cork Ltd., 739 Mountain St., plans to purchase four electric motors, each 17½ hp., also two steam boilers 25 hp.

Pump—Falmouth, Mass.—Town plans to purchase a new pump for pumping station. Estimated cost $22,000.

Pumps—Steubenville, O.—City plans to purchase and install pumps, etc., in connection with waterworks improvements. Estimated cost $75,000.

Pumps, etc.—Marshall, Minn.—City, c/o H. N. Harmon, Clk., will receive bids until Mar. 6 for pumps, etc., in connection with sewage treatment work. Estimated cost $46,500.

Pumps and Motors—Milwaukee, Wis.—Metropolitan Sewerage Commission, will receive bids until Mar. 9 for two 2,500 g.p.m. centrifugal pumps and two motors for proposed sewage booster station on Port Washington Rd.

Transformer—Wellington, N. Z.—Post and Telegraph Dept., will receive bids until April 28 for one 5,000 kw. 66/100-33/100 v. transformer for Lake Coleridge.

Industrial Projects

Calif., Orange—Orange-Mutual Citrus Association, is having plans prepared for the construction of a 90 x 110 ft. pre-cooling plant. Estimated cost $80,000. J. V. Vrybaugh, 505 Burch St., Santa Ana, is architect.

Calif., Santa Barbara — Interests, c/o J. Harnish, Hidden Valley Ranch, Hubbard Rd., plans the construction of a plant for the manufacture of brick, floor and roofing tile. Will operate under the name of Montecito Clay Products Co.

Ga., Austell—Clark Thread Co., J. B. Clark, Pres., 260 Ogden St., Newark, N. J., awarded contract for the construction of a thread mill (first unit) 3 story, 498 x 133 ft. to house 40,000 spindles, 2 story, 50 x 100 ft. warehouse, 50 x 100 ft. opener room building and 1 story boiler room here, to A. K. Adams & Co., 542 Plum St. N. W., Atlanta. Cost $2,000,000.

Ill., Chicago — Western Electric Co., South 48th and West 22nd Sts., awarded contract for foundation of a new plant to house loading coil manufacturing department at 26th St. and Cicero Ave. to W. J. Newman, 21 North Curtis St. Estimated cost $1,000,000. Condron & Post, 53 West Jackson Blvd., are architects.

Ind., Indianapolis—W. J. Holliday & Co., 545 West McCarty St. (iron), awarded contract for the construction of a plant at Missouri and Georgia Sts., to Brown & Mick, 1020 East Michigan St. Estimated cost $40,000.

N. Y., Brooklyn—Empire State Bag Co., 760 Wythe Ave., plans addition and alterations to factory at Penn St. and Wythe Ave. Estimated cost $40,000 including equipment. G. Rieger, 451 West 54th St., New York, is architect.

Pa., Glassport—Standard Oil Co. of Pennsylvania, W. E. Black, in charge, Peoples Gas Bldg., Pittsburgh, awarded contract for a bulk plant, including 1 story, 14 x 26 ft. pump house, 40 x 80 ft. warehouse, two horizontal lubricating oil tanks, 50 ft. platform, etc., here, to Weissert Bros., 2415 Lathrobe Ave., McKeesport.

Tenn., Kingsport—Tennessee Eastman Corp., c/o Eastman Kodak Co., 343 State St., Rochester, N. Y., awarded contract for the construction of first unit of plant, 4 story, 100 x 580 ft. for the manufacture of cellulose acetate yarn, 2,500,000 lb. annual capacity here, to Ridge Construction Co., 355 Lewiston Ave., Rochester. Estimated cost $1,000,000.

Tex., Refugio—Luling Oil & Gas Co., Milam Bldg., San Antonio, has made application to Railroad Commission for permit to construct a casinghead gasoline plant and plant for the manufacture of carbon black near oil and gas fields here. Amount of gas to be utilized is 40,000,000 cu.ft. daily.

Cuba, Santiago—Cuban-American Manganese Corp., controlled by Freeport-Texas Corp., 122 East 42nd St., New York, N. Y., plans the construction of first unit of plant to include electric steam shovel mining operations, milling, grinding and flotation plants, cindering plant, etc., here. Estimated cost $1,500,000. Work will be done by day labor and separate contracts.